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NATIONAL BUREAU OF STANDARDS

Technical News Bulletin

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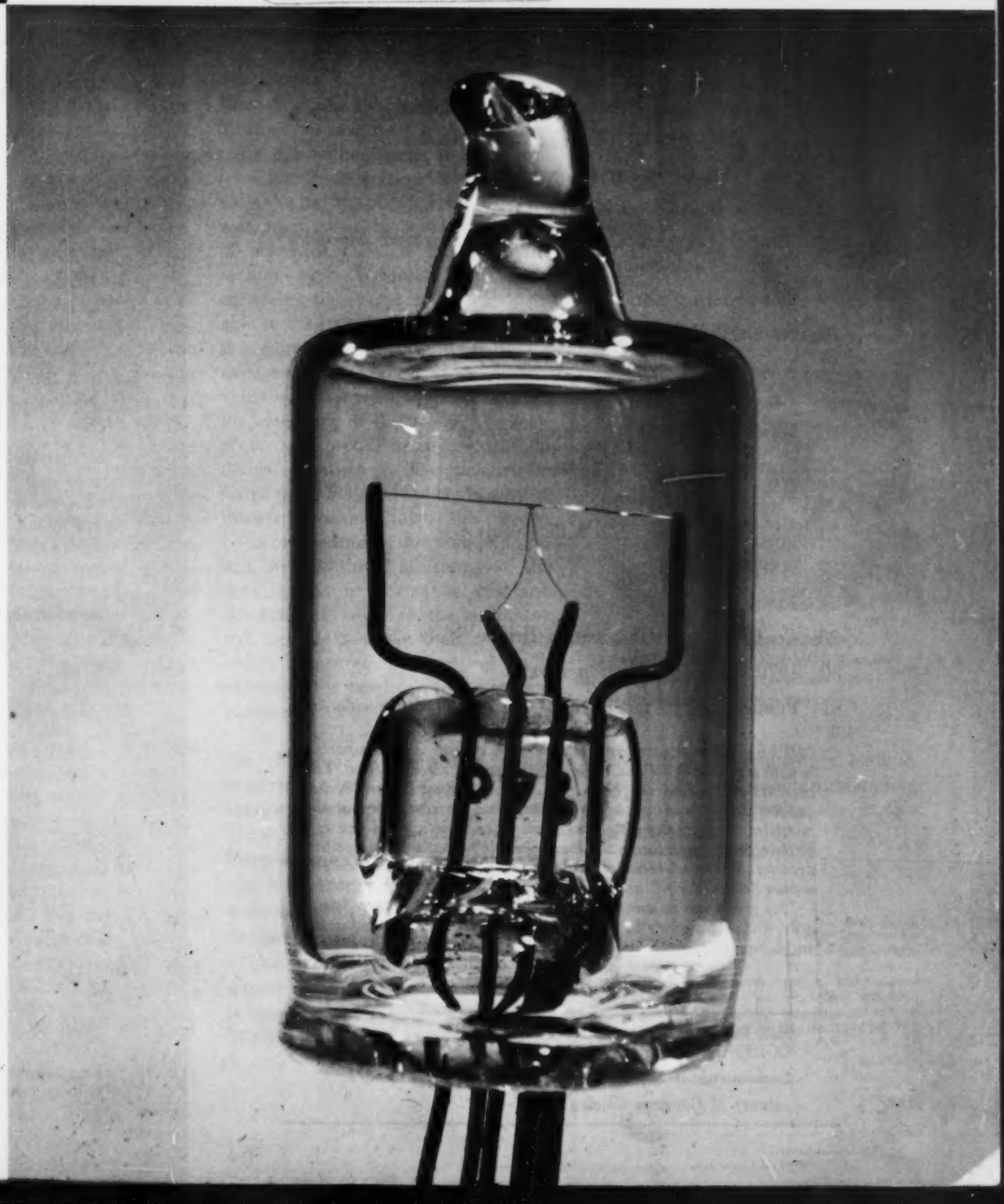

UNITED STATES DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

Technical News Bulletin

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U.S. DEPARTMENT OF COMMERCE
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NATIONAL BUREAU OF STANDARDS
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COVER: Alternating current is accurately measured by comparing it with a nearly equal and accurately measured direct current. The currents are passed successively through a thermoelement heater (about 10-mm long) to which a thermocouple is attached at the midpoint. Current differences as small as one part per million can be detected by monitoring the thermocouple output with a sensitive detector. Thermoelements provide the necessary link between DC standards and the AC quantities to be measured.

This photo was an award winner in the Institute for Basic Standards' Annual Science Photography Contest, depicting an ongoing scientific program in the Institute—in this case, that of E. S. Williams.

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The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized as follows:

- The Institute for Basic Standards
- The Institute for Materials Research
- The Institute for Applied Technology
- Center for Radiation Research
- Center for Computer Sciences and Technology

The TECHNICAL NEWS BULLETIN is published to keep science and industry informed regarding the technical programs, accomplishments, and activities of NBS.

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ACCURATE MEASUREMENTS OF JOSEPHSON JUNCTION VOLTAGE

SCIENTISTS at the NBS Institute for Basic Standards have very accurately measured [1] the voltage obtained from a Josephson junction irradiated by microwaves of a known frequency. The frequency-to-voltage conversion ratio agrees within several parts per 10 million with measurements made at the University of Pennsylvania by a similar method.[2] The accurate frequency-to-voltage conversions have very significant promise for surveillance measurements of standard cells; possible applications as standard voltages; and more accurate determinations of fundamental constants such as e (the electron charge), h (Planck's constant), and m (the electron rest mass).

In a Josephson junction ac current flows between two superconductors, cooled to below their transition temperature, when they are at different potentials. By irradiating the junction with microwave radiation, the ac voltage is altered and a "staircase" of constant voltages is obtained.

The "ac Josephson effect" converts microwave frequencies to millivolt dc voltages according to the formula

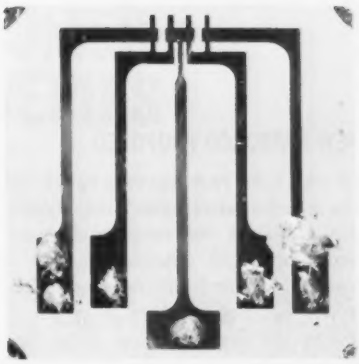
$$V = N(h/2e)f,$$

where f is the input frequency (known to parts in 100 million or better), V is the output voltage, N is an integer relating the step of the staircase voltage to the input frequency, and (h/2e) is the frequency-to-voltage conversion (nominally, the ratio of Planck's constant to the charge of a superconducting pair of electrons). Determining the ratio means that voltages can be determined from the input frequency, which is very accurately known.

The NBS measurements were made possible by the development of a new type potentiometer based on a circuit plan known as the "series to parallel comparator" or "interchangeable Hamon pair." The potentiometer, exhibiting an accuracy of better than parts per million, compares the low-level Josephson voltage (2 to 10 millivolts) with the United States legal volt, maintained by a selected group of standard cells of the cadmium-mercury type (Weston cells). The accuracy of the comparison is comparable to the stability of voltages within the standard cell group; thus, the measurements can be used for surveillance measurements to determine the constancy of the group. The technique is expected to supplement the delicate statistical intercomparisons based upon hundreds of routine measurements, which form the present basis of monitoring this voltage standard. An additional advantage of this development is that other standards laboratories, utilizing the technique, will be able to make their own constancy measurements and eventually eliminate the need for frequent comparisons with the NBS standard cells.

The Josephson junctions used in the NBS study are fabricated by first evaporating lead strips onto a 1-inch-square piece of glass through a mask. These strips are allowed to oxidize to form a thin insulating layer, after which another mask is used to apply a second set of strips, which cross the first set, to form the junction.

For irradiation, the junction is mounted inside a waveguide, which is immersed in a liquid helium bath. The liquid helium bath is itself immersed in a liquid nitrogen bath. A high-permeability shield, surrounding the apparatus, excludes the earth's magnetic fields.



Close up of Josephson junction.

Thomas Witt observes an oscilloscopic tracing of the staircase voltages obtained from a Josephson junction irradiated with microwave frequency radiation.

[1] Harris, F. K., Fowler, H. A., and Olsen, P. T., Accurate Hamon pair potentiometer for Josephson frequency-to-voltage measurements, Metrologia (in press).

[2] Finnegan, R. F., Denenstein, A., and Lengenburg, D. N., An ac-Josephson-effect determination of e/h with sub-part-per-million accuracy, Phys. Rev. Letters 24, No. 13, 738–742 (Mar. 1970).

STANDARDIZATION OF ION-SELECTIVE ELECTRODES

NEW APPROACH PROPOSED

IN THE LAST FEW YEARS a variety of ion-selective electrodes have become available for a wide range of chemical and biomedical applications, but a means for standardizing these electrodes has not yet been adopted. A convention that may now make this possible has recently been suggested in cooperative work between chemists at the NBS Institute for Materials Research and two universities. As proposed by R. G. Bates,* B. R. Staples, and R. A. Robinson,** the convention is based on theories of ionic hydration and is applicable to ionic strengths above 0.1 mole per liter.[1]

Raised above the constant temperature water bath is an ion-selective electrode cell assembly on which Bert Staples is making emf measurements.

Before an ion-selective electrode can be standardized for use in solutions, values must be assigned to the activities of individual ions in one or more standard solutions. The investigators propose that the most plausible approach to this problem is found in the Stokes-Robinson hydration theory.[2] This theory provides an equation for deriving the mean activity coefficients of electrolytes in concentrated solution. It can be extended—as was done in the present study—to divide the activity coefficient of an electrolyte into its ionic components. Once the calculation is made, the standard reference solutions can be used to calibrate pH equipment to determine the amount of a particular ion present in another solution.

Individual activities were calculated by the researchers for eleven unassociated chloride salts in concentrated solutions. The hydration model was shown to be consistent with experimental data on electrode response in sodium chloride solutions [3, 4] up to 4 moles per liter, but may be imperfect at higher concentrations. The limit of validity is generally reached when about one-fifth to one-quarter of the water solvent is bound to the ions. The investigators therefore recommend that above these limits the hydration concept be used with caution at this time.

In 1969 NBS proposed to extend the existing pH convention for single ion activities to an ionic strength of 1 mole per liter,[5] but the hydration-based convention has been found to provide a more reasonable scale for the activities of individual ions in concentrated solutions. The pH convention and the hydration theory are nearly identical at ionic strengths below 0.1 mole per liter, where the the specific differences among activity coefficients of ions of the same charge are negligible.

NOTE: The first in a series of materials have been certified for the conventional single ionic activities Na^+, Cl^-, and K^+, based on the Stokes-Robinson hydration theory. These materials, NaCl and KCl, will be issued by NBS as Standard Reference Materials 2201 and 2202, respectively, to enable researchers throughout the world to standardize their instruments on a common, conventional ionic activity scale.

*University of Florida, Gainesville.
**State University of New York at Binghamton.

For further details, see
[1] Bates, R. G., Staples, B. R., and Robinson, R. A., Ionic hydration and single ion activities in unassociated chlorides at high ionic strengths, Anal. Chem. **42**, 867 (1970).
[2] Stokes, R. H., and Robinson, R. A., J. Am. Chem. Soc. **70**, 1870 (1948).
[3] Shatkay, A., and Lerman, A., Anal. Chem. **41**, 514 (1969).
[4] Schwabe, K., and Dwojak, J., Z. Phys. Chem. (Frankfurt am Main) **64**, 1 (1969).
[5] Bates, R. G., and Alfenaar, M., Chapter 6 in Ion-Selective Electrodes, R. A. Durst, ed., NBS Spec. Publ. 314, pp. 191–214 (Nov. 1969).

NEW NBS CONSUMER INFORMATION SERIES

EVERYONE WANTS TO spend his money wisely. And today, more than ever, that's hard to do. The outpouring of goods, characteristic of modern technology, almost overwhelms us with choices. New products are constantly appearing, old products are changing, designs are complex, quality varies, and good advice is hard to come by. To help the consumer make informed decisions in the marketplace, the Bureau has initiated a Consumer Information Series. The booklets in this series contain accurate, informative material, well illustrated and easy to read, on a variety of consumer topics. Three booklets are already available—on fibers and fabrics, tires, and adhesives—with many more to come. The Series is but one part of the Nixon Administration's program to provide practical assistance to the consumer.

The first of the Series, *Fibers and Fabrics* (NBS Consumer Information Series 1, by Josephine Blandford and Lois Gurel, 65 cents) provides the information needed to select and care for fabrics, apparel, furnishings, and other textile products. The booklet discusses the commonly used natural and man-made fibers, lists the properties of the fabrics made from each fiber, and presents tips on proper handling and care.

Buying tires is a difficult decision, one with decided safety overtones. And properly using and maintaining tires is often as important a factor in tire service as making the purchase decision. *Tires, Their Selection and Care*, (NBS Consumer Information Series 2, by F. Cecil Brenner, 65 cents) provides the information needed to obtain maximum safety, wear, and performance from tires. It discusses such factors as matching the tire to driving habits, types of roads normally driven, and loads to be carried. Also covered are proper tire maintenance, and the relationship among driving habits, tire wear, and safety.

Modern technology provides the designer a tremendous choice of materials for his products, which in many cases leads the home owner to questions of effective adhesives for repair. Today, adhesives are available for the effective joining of almost all materials, no matter how dissimilar. What is needed is the right adhesive and the proper technique. *Adhesives For Everyday Use* (NBS Consumer Information Series 3, by Karl F. Plitt, 40 cents) describes the adhesives now available, and lists their major uses. Also covered are surface preparation, clamping techniques and drying times, and a series of step-by-step instructions and illustrations.

Although the Bureau does not test or recommend products, its research on measurement and standards produces information in many areas that is of potential value to the consumer. These booklets are based on material developed in technical programs carried out by NBS, supplemented by information readily available to NBS scientists and engineers. In developing each booklet, a random selection of consumers were interviewed to determine their needs for information, and industry experts were consulted for technical evaluation.

Five more booklets are now in various stages of development: *Hearing Aids, Care of Books and Documents, Flooring, Plywood,* and *Seat Belts.* Each is being prepared by Bureau personnel expert in their particular field, under the general direction of James E. Payne, editor for the Series.

The three booklets described here, and all subsequent booklets in the Series, can be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

PATENTS GRANTED ON NBS INVENTIONS

Royalty-free, Nonexclusive Licenses Available

INVENTIONS OFTEN RESULT from the research and development performed at the National Bureau of Standards. To ensure that NBS inventions having potential commercial use are made available to the public without the payment of patent royalties, NBS—or the Government agency that sponsored the NBS research leading to an invention—files patent applications on the inventions and grants royalty-free, nonexclusive licenses under the resulting patents to qualified manufacturers.

U.S. patents recently awarded to NBS inventors are briefly described below. Manufacturers interested in obtaining a license under one or more of the patents should address a request to the Office of the General Counsel, U.S. Department of Commerce, Washington, D.C. 20230, unless a different administering office is indicated. Copies of the patents may be obtained from the U.S. Patent Office, Washington, D.C. 20231, for 50 cents each.

Superconductor Switch, No. 3,436,079, granted December 23, 1969, to Vincent D. Arp.

This patent covers a circuit that can rapidly switch a large dc current, as for example, to a laser flash lamp. The current is established in a series circuit that includes a current source, a storage inductor, and a superconductive bar mounted in liquid hydrogen or helium. The lamp, whose resistance should be one-tenth or less of the normal resistance of the superconductive bar, is connected across the bar. The current is switched from the bar to the lamp by applying a critical magnetic field to the bar, thereby driving the bar into its normal state and forcing the current through the lamp.

Administering office: Office of the Judge Advocate General, Patent Division, Department of the Army, Washington, D.C. 20315.

Ultraviolet Resonance Lamp, No. 3,493,805, granted February 3, 1970, to Arnold M. Bass.

When an ultraviolet-transmitting, lithium fluoride window is sealed to the end of a glass, gas-filled resonance lamp, operation of the lamp tends to decompose the seal. This causes gas contamination and the formation of an opaque deposit of the seal material on the window. These problems are avoided in this lamp by providing a glass skirt about the lamp end and sealing the window to the skirt. This places the seal beyond the gaseous discharge.

Administering office: Office of the General Counsel, National Aeronautics and Space Administration, Washington, D.C. 20546.

High Temperature Reactions of Hexafluorobenzene to Prepare Iodo- and Bromo-Pentafluorobenzene, No. 3,499,046, granted March 3, 1970, to Leo A. Wall and Joseph M. Antonucci.

This patent covers a simple method for replacing one of the fluorines in hexafluorobenzene with iodine or bromine, thereby yielding potential monomers for the synthesis of thermally stable elastomers. The starting compound and a salt—lithium iodide, potassium iodide, or potassium bromide—are reacted under a stream of nitrogen in a hot tube containing carbon pellets, at a temperature of 500–600 °C.

Administering office: Patent Counsel, Department of the Navy, Washington, D.C. 20360.

Instrument for Measuring the Adiabatic Saturation Temperature (Thermodynamic Wet-Bulb Temperature) of a Vapor-Gas Mixture, No. 3,515,001, granted June 2, 1970, to Lewis Greenspan and Arnold Wexler.

The wet- and dry-bulb temperatures provided by a conventional psychrometer are converted to humidity values with the aid of empirical charts, because the thermometers and the air surrounding them are an open system undergoing a nonequilibrium process that cannot be completely analyzed. This instrument provides an analyzable, closed system that consists of a wick mounted in a thermally insulated tube, a helical heat exchanger mounted around the tube, and a thermally insulated housing mounted around the heat exchanger and tube. The moist air (or other vapor-gas mixture to be tested) is flowed serially over the wick and the heat exchanger, while water (or the liquid corresponding to the vapor) is counterflowed through the heat exchanger to the wick. This arrangement pre-cools the liquid to the wet-bulb temperature whereby its evaporation from the wick proceeds in a true adiabatic manner. The mixture's pressure, and its temperature upstream and downstream of the wick, are measured; these quantities can be related by thermodynamic theory to the mixture's initial mixing ratio.

Semiconductor Light Attenuator and Utilization Device, No. 3,524,065, granted August 11, 1970, to Nicholas N. Winogradoff and Herbert K. Kessler.

In this device the intense light from a high-powered laser is measured by allowing the light to fall on an etch-polished, n- or p-type semiconductor wafer and measuring the light that emerges from the wafer's rear surface. The light intensity is greatly attenuated if the wafer's band gap is less than the incident photon energy, because the holes and electrons formed in the wafer by the incident light recombine inefficiently to form the photons that emerge from the wafer.

Ellipsoidal Mirror Reflectometer Including Means for Averaging the Radiation Reflected from the Sample, No. 3,504,983, granted April 7, 1970, to Joseph C. Richmond and Stuart Thomas Dunn.

The prediction of a satellite's temperature in space requires accurate data on the reflectance of its materials. This instrument, which provides such data, includes an ellipsoidal mirror, a specimen support located at one of the mirror's focal points, and an averaging sphere and detector located at the other focal point. Radiation is focused onto the specimen through an aperture in the mirror; the reflected radiation is collected by the mirror and directed into the averaging sphere.

Administering office: Office of the General Counsel, National Aeronautics and Space Administration, Washington, D.C. 20546.

System for Producing Two Simultaneous Records of High-Energy Electrons in an Electron Microscope, No. 3,510,649, granted May 5, 1970, to L. L. Marton.

Photographing the 300-keV to 1-MeV electron images produced by some high-voltage electron microscopes is difficult because the fast-moving electrons have few collisions with the silver halide in photographic emulsions, and thereby fail to form a latent image. This system overcomes the problem by placing two planar, secondary-electron-emitting dynodes in the path of the high-energy electrons to produce low-energy secondary electrons. These secondaries are accelerated to 5–10 keV, and fall on two photographic emulsions that face the secondary emissive surfaces. Because the dynodes produce several secondaries for each high-energy electron, the recorded images are intensified versions of the original images.

Continuous Gas-Liquid Chromatography Method Utilizing Annular Open Columns, No. 3,511,028, granted May 12, 1970, to Charles Proffer Saylor.

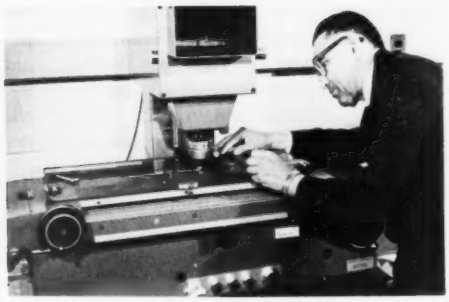
This patent covers a high-speed, high-resolution method for continuously separating a gaseous mixture into its components. An annular open column, provided by a pair of coaxial cylinders, has at least one of its cylindrical walls coated with a chromatographic separation liquid; this coated wall is then rotated about its axis. Carrier gas is flowed between the walls and constrained to flow axially through the column. The gaseous mixture is introduced into the column at a fixed point on inlet end. The components are swept axially through the column by the carrier gas and are differentially carried around the column by the rotating, liquid-coated wall. Consequently the components follow different helical paths through the column, and can be withdrawn at different points around the column outlet.

Synthesis of α-Hydroheptafluorostyrene and Improved Synthesis of Octafluorostyrene, No. 3,513,206, granted May 19, 1970, to Leo A. Wall and Joseph M. Antonucci.

This patent describes a number of methods for synthesizing the highly fluorinated compounds, α-hydroheptafluorostyrene and octafluorostyrene (perfluorostyrene). These compounds are useful as monomers, or as precursors to monomers, that form thermally stable, radiation-resistant polymers.

Administering office: Patent Counsel, Department of the Navy, Washington, D.C. 20360.

THORIUM SPECTRUM PROPOSED AS IMPROVED SECONDARY WAVELENGTH STANDARD



Romuald Zalubas positions a spectrographic plate under the eye of the automatic, photoelectric scanning comparator.

FOR MANY YEARS a better source of secondary wavelength standards than those of the iron spectrum has been needed. Because thorium lines are very sharp and homogeneously distributed throughout the wavelength region from 2.5 to 12×10^{-7} m (2500–12000 Å), they have been proposed as replacements for the older iron standards. R. Zalubas of the Bureau, A. Giacchetti of the Argonne National Laboratory, and R. W. Stanley of Purdue University have now compiled a list [1] of 1556 wavelengths of the thorium I (Th I) spectrum and critically evaluated each wavelength. The wavelengths were obtained from interferometric measurements of thorium started at NBS by W. F. Meggers and R. W. Stanley.

In 1962 the Report of the Committee on Wavelength Standards of Commission 14 of the International Astronomical Union stated: "Iron seems likely to be superseded by thorium. . . . No further work on the iron spectrum is therefore desirable as the effort would seem to be more profitably directed to an extension and refinement of the thorium measurements." [2] The number of wavelengths measured interferometrically by four laboratories increased, and in 1965 the Report expressed the following desire: "As the thorium standards have already proved extremely useful in work with high-dispersion spectrographs, the Commission notes with satisfaction the considerable efforts devoted to their perfection. The time should soon be ripe for averaging the results in a unified list for eventual adoption." [2]

The time came to develop this unified list of thorium standards with the recent NBS work on the analysis of the Th I spectrum. The composite list was an extension of Dr. Zalubas' work [3] of observing, measuring, and analyzing more than 35 000 thorium lines to derive the 523 atomic energy levels of the first spectrum of thorium. The spectra were obtained with two NBS high-dispersion spectrographs.[4] Electrodeless lamps and sliding sparks provided the spectral sources, and the spectrographic plates were measured on two photoelectric scanning comparators that record the position of each spectral line on the plate and each line's intensity. One such instrument automatically measures and records the data on magnetic tape.

While the data obtained from grating spectrograms are adequately precise for determining atomic energy levels, interferometrically obtained wavelengths are necessary for wavelength reference standards.

During the last decade wavelengths of about 1000 thorium lines were measured interferometrically. Drs. Giacchetti, Stanley, and Zalubas compiled and critically evaluated these interferometrically measured wavelengths. Then, using Zalubas' list of energy levels, they calculated 1375 Th I wavelengths with an average deviation of 0.0014 cm^{-1}. These calculated values are marked by a letter C in their list. In addition to the calculated values, another 181 lines are labeled by W since they are weighted averages of several measurements. The remaining 265 lines of this list were interferometrically measured only once, and are suggested for use only as a "last resort" in intercomparison measurements.

The 1970 Report of Commission 14 of the International Astronomical Union states: "By adding 181 accurately measured Th I and Th II wavelengths they obtain a total of 1556 lines that may be adopted as standards. This synthesis of all the measurements in the thorium spectrum made to date is a great step forward." [2]

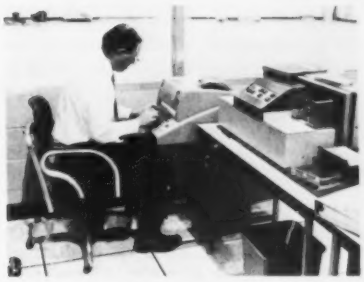
[1] Giacchetti, A., Stanley, R. W., and Zalubas, R., Proposed secondary-standard wavelengths in the spectrum of thorium, J. Opt. Soc. Am. **60**, No. 4, 474–489 (Apr. 1970).

[2] Transactions of the International Astronomical Union XI B, 212 (1962); XII A, 140 (1965); XIV A, 126 (1970).

[3] The spectrum of thorium: New secondary standards of wavelengths, Nat. Bur. Stand. (U.S.), Tech. News Bull. **44**, No. 10, 163–164 (Oct. 1960).

[4] Improved image focus of spectrograph, Nat. Bur. Stand. (U.S.), Tech. News Bull. **53**, No. 11, 243 (Nov. 1969).

TIME-SHARING COMPUTOR AT NBS REACTOR



In a room atop the NBS reactor, Edward Prince teletypewrites instructions to the computer used to run the experiment illustrated below.

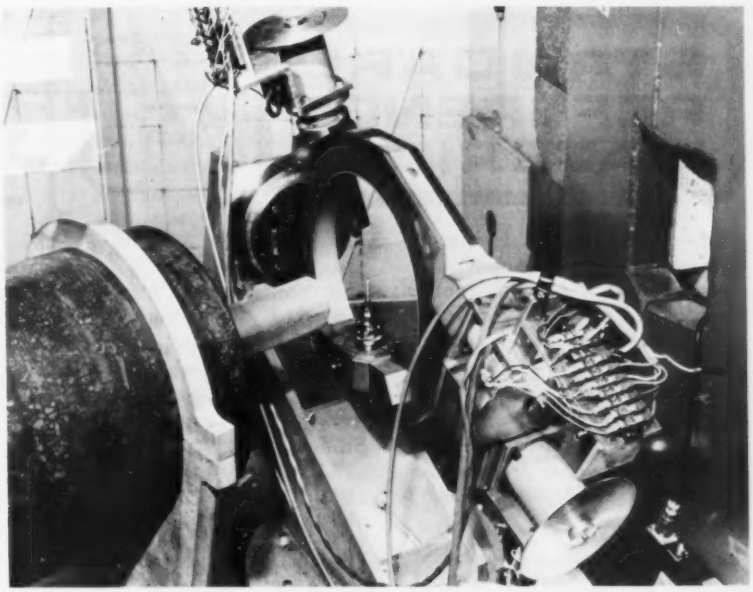
AN ON-LINE, TIME-SHARING COMPUTER maintains efficient operation of the high flux nuclear reactor at the Bureau.[1] The computer operates equipment, records and analyzes data, and proceeds from one experiment to the next automatically. The extensive mechanical and electrical system, joining the computer to the reactor, was designed and developed by Edward Prince of the Reactor Radiation Division and Harvey A. Alperin of the Naval Ordnance Laboratory, with assistance from Louis Paolella of the Naval Research Laboratory and Alan Tudgay of NBS. Partial support for the development was provided by the Navy.

The computer runs several instruments used to study the structure and dynamics of crystals, liquids, and glasses. To date, these include four neutron scattering diffractometers, a triple-axis spectrometer, and an x-ray diffractometer located in another Bureau laboratory.

Underlying the design of the computer's hardware and software are three basic requirements. First, the computer is able to collect and analyze any data an experiment may produce. For example, many different parameters may be recorded; each parameter may require different degrees of accuracy; and recorded values may actually be sums, differences, or averages of many accumulated points. Next, each experiment is run independently of any other experiment, even though the independent time-sharing capability required extensive programming. Finally, it is possible for virtually all user programs to be written in the widely accepted FORTRAN compiler language.

There are two classifications of computer programs: system programs that control overall computer operations, and user programs that apply to computation and control of a user's particular experiment.

System programs are divided into off-line and on-line modes. [The computer is said to be operating off-line when it is not capable of affecting any instrumentation or accumulating data.] The off-line system contains



A crystal is mounted on the end of a rod and positioned within a goniometer (center) for analysis using a neutron scattering technique. Neutrons coming from the reactor (right) are scattered from the crystal and detected at left. All positioning of the equipment is done by the computer.

411-036 O - 71 - 2

programs for the general management and bookkeeping of experimental operations. These include the FORTRAN compiler, loader, and library; and other general purpose programs. The on-line system contains the programs to control experiments and day-to-day routine operations.

User programs, directly related to particular experiments are divided into two categories, designated as level 1 and level 2. Level 1 programs are written by the researcher and run the entire experiment. Level 2 programs perform operations such as "manual" operations of the diffractometers at times when a person is actually waiting for a response. Teletypewriters are located at each experiment, enabling the experimenter to communicate directly with the computer in order to alter experimental procedures, or to obtain up-to-date data results.

Logic signals, generated by the computer, are translated by means of special electronic circuits into the electrical signals required for driving motors. Counter signals, and certain others produced by the equipment, are similarly translated into logic signals that can be read by the computer.

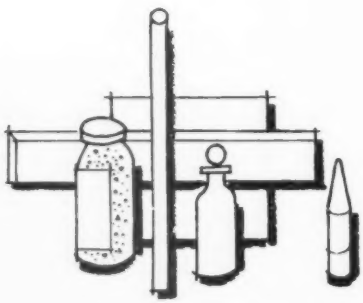
An experiment that exemplifies computer operations was the recent determination of the positions of hydrogen atoms in an apophyllite crystal. This unusually structured, hydrated mineral (potassium calcium fluorosilicate) could not be analyzed using the usual x-ray diffraction technique. Using neutron diffraction, Edward Prince showed that the hydrogen atoms were not all incorporated in a water molecule as supposed, but some were attached to the fluorine atoms, appearing as hydrogen fluoride.

All mechanical operations, including moving the crystal, irradiating it with neutrons, and detecting and recording the scattered neutrons, were done automatically by the computer for a large number of crystal planes, scattering angles and neutron energies. The collection of the data for this experiment took about six weeks, during which only a few hours of Dr. Prince's time were required.[2]

[1] Alperin, H. A., and Prince, E., **A time-shared computer system for diffractometer control**, J. Res. Nat. Bur. Stand. (U.S.), **74C** (Engr. and Instr.), Nos. 3 and 4, 89–95 (July–Dec. 1970).

[2] "Diffractometer Control System: A System for Easy Man-Machine Communication," NBS Motion Picture, 16-mm color/sound; 15 min.; 1969. Available on loan from NBS.

STANDARD REFERENCE MATERIALS



Standard Reference Materials are well characterized materials certified for chemical composition or for a particular physical or chemical property. These materials are disseminated by NBS to be used to calibrate and evaluate measuring instruments, methods, and systems or to produce scientific data that can be referred readily to a common base.

CERTIFIED GAS STANDARDS

A new series of four Hydrocarbons in Air Standards has recently been issued by NBS Office of Standard Reference Materials.[1] These standard reference gases, hydrocarbon-in-air (in which the hydrocarbon is predominantly methane), are supplied in four concentrations. These hydrocarbon concentrations, calculated as methane-in-air, are as follows:

SRM 1610
0.103±0.001 mole percent
SRM 1611
0.0107±0.0001 mole percent
SRM 1612
0.001 17±0.000 01 mole percent
SRM 1613
0.000 102±0.000 002 mole percent

The limit reported for each standard reference material is the 95 percent confidence interval of the mean. These materials supplement the six oxygen in nitrogen and three carbon dioxide in nitrogen SRM's previously issued by NBS.

Because of the close association between oxidants in polluted air and the photochemical reactions leading to them, great interest has developed concerning the concentration of hydrocarbons both in air and in exhaust and vent gases. The most convenient method for estimating total concentration of these gases is through the use of the flame-ionization analyzer. Like most instrumental techniques, flame-

ionization produces relative results that, to be reproducible and to be comparable with other instrumental results, must be periodically calibrated against a standard. The presently announced Certified Gas Standards for Hydrocarbons in Air provide such standards.

The yearly mean concentration for hydrocarbons in major American cities is less than 5 ppm. The maximum five-minute period concentration may range from 10 to 40 ppm. Exhaust gases collected from an automobile may run well over 1000 ppm. The range of hydrocarbon concentrations represented by Standard Reference Materials 1610 through 1613 furnishes fixed points to cover much of this concentration range.

These standard reference materials were prepared by the stepwise dilution of methane with air to the desired concentration. The final value for hydrocarbon concentrations, as well as the concentration for each intermediate mixture and in the diluent gases, were determined analytically by a flame-ionization method. The validity of the results obtained by this method was assured by comparison with a set of primary laboratory standards prepared by weighing the individual components on a precision analytical balance.

The Certified Gas Standards for Hydrocarbon in Air are part of the gas chemistry program being carried out in the Analytical Chemistry Division of the NBS Institute for Materials Research. Previously, standard reference materials in the 1600 series were prepared for carbon dioxide levels in nitrogen (SRM's 1601, 1602, and 1603) and oxygen levels in nitrogen (SRM's 1604 through 1609). Work on other atmospheric constituents, both normal and pollutant, is currently in progress.

The Hydrocarbon in Air Certified Gas Standards are shipped in disposable cylinders at approximately 500 pounds per square inch pressure. The cost of each is $174 for 68 liters under standard conditions.[2]

CADMIUM AND SILVER VAPOR PRESSURE STANDARDS

Two new metal vapor pressure standards of cadmium and silver have been certified by OSRM to supplement the temperature range covered by the gold vapor pressure standard already available. These vapor pressure SRM's should be of particular interest to laboratories making vapor pressure measurements using the Knudsen, torque Knudsen, or mass spectrometric techniques at near room temperature (cadmium) or at high temperatures (silver).

The vapor pressures of cadmium and silver, both 99.999+ percent pure, have been accurately determined. The values for cadmium, SRM 746, have been certified over the pressure range of 10^{-11} to 10^{-4} atmosphere and the temperature range 350 to 594 K. Those for silver, SRM 748, have been certified over the pressure range of 10^{-12} to 10^{-3} atmosphere and over the temperature range 800 to 1600 K. The values for gold, SRM 745, are certified over the pressure range 10^{-8} to 10^{-3} atmosphere and over the temperature range of 1300 to 2100 K. Platinum and tungsten will later be added to this series to fully extend the temperature range from 350 to 3000 K.

Standards are needed in the field of vapor pressure measurements where such measurements may commonly differ by 30 to 50 percent, even when made by experienced investigators. The new SRM's may be used to test and calibrate vapor pressure measurement apparatus and techniques, as well as to detect possible systematic errors. These materials can also be used for direct interlaboratory comparisons.

A statistical analysis of the cadmium and silver temperature-pressure values, which are based on the data of at least six experienced laboratories, has provided an estimate of uncertainties expected in the measurement of vapor pressure-temperature curves. Evaluations of uncertainties were made for (1) the slope of the curve as expressed by the second law heat of sublimation, and (2) the absolute value of the vapor pressure as expressed by the third law heat of sublimation. The methods of analysis used for cadmium and silver were similar to those used for gold,[3] SRM 745.

The NBS work leading to the certification of SRM's 746 and 748 was performed by Robert C. Paule and John Mandel of the Institute for Materials Research.

SRM's 746 and 748 are each supplied in the form of rods 6.4 mm (¼ in) in diameter and 64 mm (2½ in) long for $65 and $75 per unit, respectively.[2] A Certificate of Analysis is supplied with each material.

CORRECTION—In the November 1970 issue the caption for the cover illustration should have read: ". . . the absorbed dose distribution following absorption in distilled water of a burst of electrons with average energies of about 1.5 MeV." The caption for the illustration on page 256 should read: ". . . the absorbed dose distribution following a pulse of electrons with average energies about 2.0 MeV."

The numbers 28 kV and 35 kV that appeared in the captions actually refer to the charging voltage of the capacitors in the pulsed x-ray generator. Since there are seventy of these generators, charged in parallel and discharged in series, the maximum electron energies corresponding to 28 and 35 kV are about 2.0 and 2.5 MeV. These electron pulses have a wide spread of energy, however, so the average energies are approximately 1.5 and 2.0 MeV.

[1] For a complete list of Standard Reference Materials available from NBS, see Catalog of Standard Reference Materials, NBS Spec. Publ. 260 (July 1970 ed.) for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 75 cents; order by SD Catalog No. C13.10:260.

[2] These materials may be purchased for the prices indicated from the Office of Standard Reference Materials, Room B308, Chemistry Bldg., National Bureau of Standards, Washington, D.C. 20402.

[3] Paule, R. C., and Mandel, J., Analysis of Interlaboratory Measurements on the Vapor Pressures of Gold (Certification of Standard Reference Material 745), Nat. Bur. Stand. (U.S.), Spec. Publ. 260–19. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 30 cents. Order by SD Catalog No. C13.10:260–19.

MEASUREMENT STANDARDS, LANGUAGE OF DISCOVERY

Excerpts from the opening address
by L. M. BRANSCOMB, Director, NBS,
at the Conference on Precision Measurement
and Fundamental Constants

NO PREVIOUS CONFERENCE covering similar subject matter has brought together the three groups we have here: theorists exploring basic processes in the framework of quantum electrodynamics and the nature of the superfluid state; experimentalists interested in precision measurement of fundamental properties; and physicists concerned with perfecting the scientific measurement system. All three groups share an active concern for the improvement of our knowledge of the fundamental constants of nature—and the continual probing of the limits to which we know them to be invariant in time and space. Without the help and advice of all three, an analysis of the most probable values of the constants is not possible.

Even more important, no one of these three groups can succeed without the other two for reasons that are inherent in the way in which physics makes progress. Superficially, of course, quantum electrodynamicists require exceedingly precise and accurate measurements of properties calculable in terms of the constants, such as Lamb shifts, lepton magnetic moments, hyperfine structure and, so forth, to verify their higher order correction calculations and to test their models for proton structure and the like. Or, if you prefer to take the other point of view, a physicist wishing to deduce the best values of the constants from precision experiments cannot do so with Maxwell's equations and classical mechanics alone; he needs the now well-verified theory of quantum electrodynamics and can call up as many higher order corrections as he likes. Of course the theorist can pursue his investigations using the fundamental constants as parameters of his theory—assuming them to be perfectly invariant—without ever knowing how anybody would realize in the laboratory the absolute ohm. But, he still cannot settle disputes with his colleagues who prefer different models unless there is an experiment with which to compare, and which has the needed accuracy and reliability to make the comparison meaningful.

Note how intimately the fundamental UNITS and the fundamental CONSTANTS are interrelated. If we start without any knowledge of physics and have no idea what might be a set of natural invariant parameters in terms of which we can describe physical phenomena, we have to start by picking a few gauges that seem reasonably invariant to human experience. The period of a pendulum, and length and mass of two platinum-iridium objects, and the temperature interval between two phase transitions in water seemed like a good place to start. With these tools to create a measurement language capable of independent empirical reproduction, one laboratory can share experience with another using only a written language to do so.

One purpose of this Conference, then, is to discuss how well we define, realize and transfer the basic units of our measurement language—the language in terms of which a meaningful discussion of the constants—and therefore the basic questions of physics—must be conducted. This is not a matter to be left to the metrologists alone, as though an administrative detail and not a matter of physics.

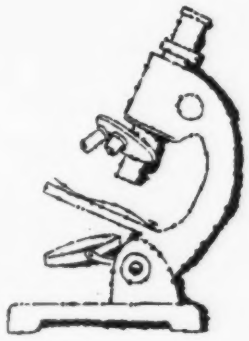
The accuracy with which basic units must be realized is a function of demands placed upon them by the tests of basic physics made in terms of them. Since the progress of knowledge in basic physics is dependent upon the availability of this accuracy, the two are locked together in mutual interdependence. There is actually a three-way interdependence between the capabilities of the measurement system, the knowledge of the invariant properties of the physical world, and the march of measurement technology. Using the measurement system, physics makes progress both with understanding and with new technology. Using the understanding and the technology we improve the measurement system—for example by the adoption of atomic standards for length and time interval. And simultaneously applied science takes the technology and puts it to use—for example by using atomic clocks for pulse code modulation communications or for ship and aircraft navigation.

We at NBS are keenly interested in exploring with you the needs and ideas for improving the measurement system as it relates to the investigation of the fundamental constants and the underlying physics. To be sure, you can't order up a better volt or a more precisely transferable kilogram for the asking. But some of the toughest problems are applied problems capable of planned attack and solution. For example, when the Josephson effect suggested a way to improve the realization of the volt, the need for accurate potentiometric measurements at the nanovolt level was identified and met.

The interplay between basic physics, evaluation of the constants, and realization of the measurement system not only impacts the accuracy requirements for the measurement system, but the evolution of the definitions or theoretical realizations of the units themselves. Our measurement system is a living language. All physicists should take an active interest in its evolution, and not leave it to a few measurement experts around the world.

The course of scientific investigation reveals patterns of systematic behavior and suggests sets of invariant parameters in terms of which observations are most simply described. It will often turn out that within the framework of a specific technique for observation—let's say relative atomic masses or atomic resonances—the precision with which these relative observations can be made exceeds the accuracy with which all the observations can be expressed in units of the basic measurement language. At this point one must re-evaluate the structure of the measurement language. To what extent do we proliferate the creation of new measures—such as the atomic mass unit, the Siegbahn X unit, the electron volt and the chemical calorie—or do we change or improve the means for defining, realizing and transferring the primary units of the measurement system?

The main source of conflict in the evolution of the international measurement language is diversity versus uniformity. At the most sophisticated level, the measurement language not only tolerates but requires a great deal of diversity. Physicists must be multilingual in common measurement speech, in the "natural" systems of units using the fundamental constants as parameters, in SI or cgs electrical units as they please and find convenient, even inventing new units if necessary. Specialists also use shorthand measurement slang, for example: measuring the temperature of a plasma in kilovolts to describe the best fit to



a Boltzman distribution for the excited states of Fe XIV. But as we move to lower levels of sophistication—into applied science, engineering, commerce, and finally the general public's use of measurement, the number of people involved grows, the problem of interdisciplinary communication worsens, and the need for simplicity and uniformity grows.

Meeting both these needs is the task of the oldest and least conflict-ridden international treaty organization for scientific cooperation the world has known, the General Conference of Weights and Measures established by the Treaty of the Meter, whose centennial we will celebrate in five years. Forty nations adhere to the treaty and meet in full diplomatic formality at regular intervals to consider improvements in the internationally and legally agreed on recommended system of scientific measurement. The General Conference of Weights and Measures conducts its work between conferences through two instrumentalities: the Comité International des Poids et Mesures (CIPM) with its several consultative committees and a unique international laboratory, the Bureau International des Poids et Mesures (BIPM) at the Pavillon de Breteuille in Sevres near Paris.

Through the work of this laboratory, and the Consultative Committees of the CIPM—particularly that dealing with Units—the General Conference has developed the International System of Units (SI). National governments and other international organizations—both official such as the International Organization for Legal Metrology (OIML) and private like the International Organization for Standardization (ISO)—are taking actions that will steadily increase the universality of SI units in commercial and industrial usage. Whether scientists like to speak SI or not, they will find that increasingly the industrially manufactured equipment they use will be displaying output in SI units.

Another matter I would like to discuss is often referred to as the "adjustment of fundamental constants" or, as I prefer to call it, "evaluation."

Let me emphasize once more that the purpose of this Conference is NOT to produce another evaluation of the constants. The Conference announcement says,

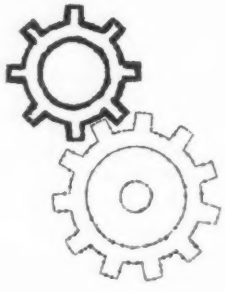
> "The objective of the Conference is to discuss modern techniques of precision physical measurement and their application, along with modern theoretical developments, to the determination of the fundamental constants. It is not the purpose of the meeting to arrive at new adjusted values of the constants, but it is expected that the substantive discussions at the Conference will help provide a basis for future adjustments."

Furthermore, it is not the intent of the organizers to restrict in any way anyone's freedom to undertake such an evaluation if he wishes. Quite the contrary. Careful evaluation of the constants has been a labor of love for many years. For the devotion of a few dedicated people all of science should be grateful. Starting with the *International Critical Tables* and the *Handbuch der Physik* in 1926, the history of the most notable evaluations—at least in this country—surrounds only a few names.

Many purposes may motivate an evaluation of the constants, but two limiting cases must be recognized. Since the constants are the parameters for theoretical physics, just as the units are the language for the operational description of observations, every scientist using physics theory must use values of the constants when comparing theoretical expectation with reality. In the overwhelming majority of the cases the fully available precision of our knowledge of the constants is not needed. But since the user can scale his prediction with the values of the constants used as parameters, it is absolutely essential that he know and accurately communicate what values he actually used. Obviously this problem is simplified if everyone in the world uses the same values of the fundamental constants. Short of assigning these constants arbitrary values, for example unity, this requires agreement on what values to use and some means for changing them as knowledge improves. On the other hand, the process of evaluation is itself a matter of physics judgment. Indeed it is one of the most demanding tasks a physicist can face, for he must reliably extract all the information content in an enormous range of experiments in the context of very sophisticated theoretical understanding. Thus there can be no unique "best" values that are not arrived at either by autocratic methods or methods that throw away information. Yet it is only from the use of all the information that the consistency of our understanding of physics can be tested. How can both the general user of physical constants and the specialist probing the limits to which theory has been shown to be reliable be served?

We must have *both* active intellectual competition in the evaluation of the constants, and a reliable, effective means for world wide adoption of recommended values.

For the first purpose, *Reviews of Modern Physics* was pleased to receive the paper [1] of Taylor, Parker, and Langenberg precisely because it was a thoughtful but still personal presentation of their views as they sought to obtain best values—best in the sense that they best suited their own purpose in making the adjustment. And they had the courage to reach a conclusion, namely that "it appears that all is not well with quantum electrodynamics." That may or may not be the consensus view of those who are here—indeed the consensus might be different on Thursday from what it is today. But I hope it stimulates others to consider the problem from alternative viewpoints and do an equally conscientious job. I suspect that somewhat different constants might result; I am not sure the error statements would overlap. But even more important, different conclusions about physics might emerge.



Yet if we were to receive a series of such reviews—say one every year—chaos might result from the confusion of literature citations, the difficulty of finding out what constants were put into each of thousands of computer programs in order to tell whether the data or the algorithms caused identical theories to yield numerically different results.

The recommended cure: CODATA, the Committee on Data for Science and Technology of the International Council of Scientific Unions.

I suggest that CODATA should not attempt to publish a set of "best" values—which cannot be competently done by a committee, especially an international committee. They should publish, preferably at regularly scheduled intervals, a set of "recommended" values to be used by those whose needs are satisfied by less than the full accuracy that is potentially available. Those who want to fight about a fourth order correction in QED, or who suspect that space might not be isotropic would be referred to their friendly literature.

This still leaves unanswered just what numerical values to use and how to describe the errors. Hopefully the errors would be conservative and every major standards laboratory would adopt the values recommended for routine use in their own work, review, and other information systems they operate. Indeed an international, multilingual set of pocket cards, whose color changes with each updating, might be a good project for CODATA if its Task Force is successful in resolving these issues.

Let me also remark about "meaningful" comparisons between experiment and theory. My brief experience as editor of a journal that is somewhat grimly insisting that authors *critically evaluate* the data with which they compare theoretical expectations is very disappointing. It is obvious that many scientists simply do not—or cannot—do this. Sometimes the reason is laziness, or lack of experience in experimental physics. But all too often it is because the literature they are reviewing simply cannot be critically evaluated because the in-

(*Continued on p. 31*)

Ellen Perzella prepares to depress the brake pedal to supply data for Richard Radlinski in the Bureau's study of the braking capability of women drivers.

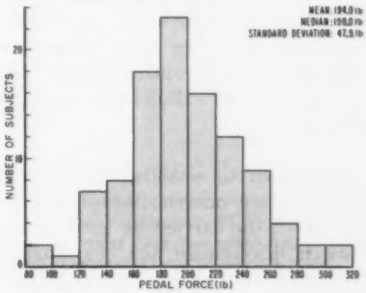
PANIC STOPS: ARE WOMEN STRONG ENOUGH?

CURRENT AUTOMOTIVE STANDARDS specify some levels of brake performance which for some cars can be obtained only by applying as much as 200 pounds of force on the brake pedal, simulating an actual panic stop after considerable brake fade. Because women are, on the average, not as strong as men, automotive research engineers of the NBS Office of Vehicle Systems Research wondered how many women could push the brake pedal this hard. In work sponsored by the Department of Transportation, engineers Richard Radlinski and James Price measured the force that 105 women volunteers applied to the pedal and found that most could not reach 200 lb. In fact, 20 percent could not exceed an average sustained pedal force of 135 lb in one late-model American car and 165 lb in a second car.[1] These results raise serious doubts about the practicality of the present allowed pedal force levels. An auxiliary finding of this program is that the forwardmost seat position was used more frequently than any other in both cars, indicating that provision for additional adjustment may be desirable.

Automotive Controls

For safety, automotive controls must be designed so that all drivers are able to use them. Power assists help weaker drivers,* but many cars are still sold without power brakes. Unassisted braking systems should therefore perform satisfactorily with pedal force inputs which are within the capabilities of women drivers.

Force for brake system operation has been specified by the Department of Transportation [2] and by the Society of Automotive Engineers [3] in performance requirements. Both sources permit a 200-lb pedal force for braking under some conditions.



Histograph of average maximum pedal force applied by 105 women for one of six test applications.

*A not unmixed blessing, since failure of the assist mechanism results in significantly higher required pedal forces.

Measuring Braking Forces

NBS appraised the appropriateness of the 200-lb maximum force requirement by measuring the force that could be exerted by 105 women volunteers. The subjects, most of them Bureau employees, ranged from 59 to 69 inches in height, 102 to 206 lb in weight, and 18 to 62 years in age.

Two stationary test vehicles were used, both late model American cars, one having an adjustable bench-type front seat, the other having adjustable bucket seats. The driver's seats in both were equipped with lap-type seatbelts, which were worn during the measurements.

Pressure transducers installed in the hydraulic system of each of the test vehicles indicated brake fluid pressures on a 2-channel stripchart recorder, which had been statically calibrated against pedal force. One car was equipped with a solenoid-operated bypass which could disable half of the dual hydraulic system in simulation of partial system failure. When the system was "disabled," pedal travel was increased by about 3 inches.

Each subject was asked to sit in one automobile, to adjust the seat and belt to her liking, and to depress the brake pedal as hard as possible for 5 seconds; following this the subject was encouraged to try harder in again depressing the pedal for 5 seconds. Then half of the hydraulic system was disabled and the subject was asked to depress the pedal as hard as possible for two 5-second intervals. Following this the subject seated herself in the second car, adjusted the seat and belt, and depressed its brake pedal for two 5-second intervals.

Test Findings

The NBS researchers used the second of each pair of pedal forces, which they felt to be more indicative of the maximum capability of each subject. Average and median forces of 175 lb were developed in the car with bench seats, with only about a quarter of the subjects exceeding 200 lb. When the system in this car was partially disabled the mean force developed was only 132 lb and the median 130 lb. The mean and median forces found for the second car were 194 and 190 lb.

Conclusions

In general, the findings show that women can't depress brake pedals with the maximum force allowed by the standards and that this inability appears to be unrelated to the height, weight, or age of the subject. The researchers also noted that the greater forces obtained in the second car may result from firmer construction of its seats. They believe that the 200-lb requirement is unrealistic and recommend that maximum force required be redetermined.

The increased pedal travel resulting from simulated brake failure greatly decreased the force the subjects could apply. This probably resulted from the increased distance from the seat to the brake pedal. That some subjects may have preferred seat adjustment further forward is indicated by the fact that 24 percent of the subjects used the seat in the foremost position in the one car and 39 percent in the second.

[1] Radlinski, R. W., and Price, J. I., **A Study of the Brake Pedal Force Capability of Adult Females**, Nat. Bur. Stand. (U.S.), Tech. Note 557 (Oct. 1970). Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402; order by SD Catalog No. C13.46:557 for 35 cents.

[2] Federal Motor Vehicle Safety Standard 105.

[3] SAE Recommended Practice J937a, Service Brake System Performance Requirements.

MEMBRANE ROOFING RESEARCH PROJECT

A two-year Membrane Roofing Research Program backed by an Owens-Corning Fiberglas Corporation research grant is now getting under way at the Bureau's Building Research Division.

Designed to establish meaningful performance criteria, the joint program will be carried on in NBS research laboratories and coordinated by an Owens-Corning appointee. Research officials of both organizations will meet periodically at the Bureau's Gaithersburg, Md., laboratory complex or at the Owens-Corning Technical Center in Granville, Ohio.

An NBS team of engineers, chemists, and materials technologists has been assigned to the joint program. Skilled in both laboratory and on-site investigations, the multidisciplinary team is utilizing Bureau facilities ranging from weatherometers, load-strain testers, thermal mechanical analyzers, and the like to environmental chambers large enough to enclose a full model house and encompass temperatures from −50 °F to about 150 °F.

Recognizing wide variations in performance of membrane roofing in various climates, the researchers will approach the problem in a series of phases including: a review of currently available information; field investigations; laboratory testing in the controlled environmental chambers; superimposing of forces on membranes to represent deck movement, traffic, icing, and other external forces; thermal and moisture change forces; and review of the state-of-the-art of field practices.

STANDARDS AND CALIBRATION

STANDARD FREQUENCY AND TIME BROADCASTS

High-frequency radio stations WWV (Fort Collins, Colo.) and WWVH (Maui, Hawaii) broadcast time signals on the Coordinated Universal Time (UTC) system as coordinated by the Bureau International de l'Heure (BIH), Paris, France. The NBS time scale, UTC(NBS), and the U.S. Naval Observatory time scale, UTC(USNO), are jointly coordinated to within ±5 microseconds. The UTC pulses occur at intervals that are longer than one coordinate second by 300 parts in 10^{10} during 1971, due to an offset in carrier frequency coordinated by BIH. To maintain the UTC scales in close agreement with the astronomers' time, UT2, phase adjustments are made at 0000 hours Greenwich Mean Time (GMT) on the first day of a month as announced by BIH. *There will be no adjustment made on February 1, 1971.*

The low-frequency radio station WWVB (Fort Collins, Colo.) broadcasts seconds pulses without offset to make available to users the standard of frequency so that absolute frequency comparisons may be made directly, following the Stepped Atomic Time (SAT) system. Step time adjustments of 200 ms are made at 0000 hours GMT on the first day of a month when necessary. BIH announces when such adjustments should be made in the scale to maintain the seconds pulses within about 100 ms of UT2. *There will be an adjustment made on February 1, 1971. The seconds pulse emitted from WWVB will be retarded 200 ms.*

NBS obtains daily UT2 information from forecasts of extrapolated UT2 clock readings provided by the U.S. Naval Observatory with whom NBS maintains close cooperation.

IMPROVED SLIDING-SHORT EASES MICROWAVE MEASUREMENTS

Fabricating a sliding-short by encasing cylindrical brass slugs in a block of polytetrafluoroethylene (PTFE) yields superior electrical and mechanical properties. Designed to be carefully positioned inside precision waveguide when making precise microwave measurements, the PTFE carrier permits stable and precise positioning, prevents the brass slugs from touching the waveguide and yields higher attenuation and flatter frequency response than existing designs.

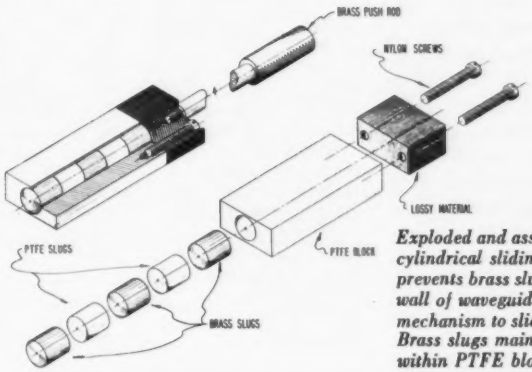
Developed at NBS at Boulder, Colo., the new design permits greater ease in making precision phase-shift measurements at microwave frequencies. The PTFE block moves more smoothly and with very little binding or lateral movement as compared to brass dumbbell designs that depend on thin PTFE spacers for proper positioning.

In addition, the three brass slugs are electrically isolated by PTFE spacers. Precise spacing and dimensioning provides optimum attenuation and frequency response.

A sliding-short device acts as a short circuit to microwave energy by reflecting maximum energy back down the waveguide to the source. This property is useful for microwave tuning, return loss, and phase-shift measurements. When making precise measurements, it is important that the brass slugs do not contact the inside of the waveguide or move laterally with respect to the waveguide axis.

Other sliding-short designs are typically two- or three-section dumbbell configurations in which the brass slugs are machined from round stock, with a thin rod section interconnecting and supporting each slug. Thin rectangular insulating guides are then attached to position the metal parts on the axis of the waveguide. During axial motion these designs have a tendency to twist and tip, allowing the metal parts to physically contact the waveguide, introducing measurement errors, noise, and physical damage to the waveguide.

Encasing the metal slugs in a PTFE-block carrier prevents metal to metal contact with the waveguide, eliminates a conductive path between the three slugs, accommodates PTFE spacers between slugs and provides mechanical stability during axial travel.



Exploded and assembled views of a 3-section cylindrical sliding-short. PTFE block prevents brass slugs from contacting inside wall of waveguide and provides a stable mechanism to slide within the waveguide. Brass slugs maintain a light press fit within PTFE block; PTFE slugs maintain optimum spacing between brass slugs.

POLICY FOR NBS USAGE OF SI UNITS

The International System of Units (SI)[1] was defined and given official status by the General Conference on Weights and Measures in 1960. In 1964[2] NBS adopted the SI for use by its staff, and issued a statement interpreting this policy in 1968.[3] While the basic policy remains unchanged, experience has shown the need for slight revisions of interpretation, which are incorporated in the text below.

The International System of Units (SI) was adopted by the General Conference of Weights and Measures (CGPM) in 1960 as the recommended units for use in science and technology. The general adoption of SI is intended to facilitate technical communications. This is a complex task, since we must be concerned about communications among scientists, between scientists and engineers, among engineers, and comprehension of technical material prepared for laymen. Universality of comprehension is fostered by universal use of a single international system; quick and easy communication among specialists is fostered by the use of specialized language of the art. While specialized language will always have a place in science, all scientists have an obligation to make their work effectively available to others outside their disciplines. For this reason, the policy of NBS is to encourage the use of SI units in all cases where scientific communication will not be impaired by doing so. A complete transition to SI units will require considerable time, and an abrupt change might in some instances defeat the primary purpose by causing unnecessary confusion. In every case, NBS publications should attempt to educate the reader by quoting SI equivalents when other units are used.

Although customary or "English" units are still dominant in U.S. commercial and engineering practice, the ISO (recommendation R–1000) strongly recommends the use of SI units in all ISO standards. The ASTM and other U.S. standards writing bodies are giving data in both customary and SI units. It is our policy to encourage the diffusion of familiarity with SI units throughout the engineering community by appropriate use in engineering standards literature.

No system of units can be expected to remain static, and evolutionary modifications in the SI will probably occur as improvements are made in measurement techniques and in understanding of physical phenomena. In certain advanced fields of science the SI may become outdated or unsuitable. In such cases, the practice of the pertinent part of the scientific community should be followed. Nevertheless, central or essential findings should be presented in SI units as well as in the units preferred by the author.

The SI is constructed from seven base units† for independent quantities, plus two (supplementary) units for plane and solid angle. Units expressed as combinations of the foregoing are called derived units.

SI Base Units

Physical Quantity	Name of Unit	Symbol
length	metre*	m
mass	kilogram	kg
time	second	s
electric current	ampere	A
thermodynamic temperature	kelvin	K
luminous intensity	candela	cd
amount of substance	mole	mol

*The spelling *meter* is also acceptable.

SUPPLEMENTARY UNITS

The SI units for plane and solid angle are the radian (rad) and steradian (sr), respectively.

†The seventh unit is the mole, which has been recommended by the CIPM and will be considered for adoption by the CGPM in 1971.

Special Names and Symbols for Certain SI Derived Units

Physical Quantity	Name of SI Unit	Symbol for SI Unit	Definition of SI Unit
force	newton	N	$kg \cdot m \cdot s^{-2}$
pressure**	pascal	Pa	$kg \cdot m^{-1} \cdot s^{-2} (= N \cdot m^{-2})$
energy	joule	J	$kg \cdot m^{2} \cdot s^{-2}$
power	watt	W	$kg \cdot m^{2} \cdot s^{-3} (= J \cdot s^{-1})$
electric charge	coulomb	C	$A \cdot s$
electric potential difference	volt	V	$kg \cdot m^{2} \cdot s^{-3} \cdot A^{-1} (= J \cdot A^{-1} \cdot s^{-1})$
electric resistance	ohm	Ω	$kg \cdot m^{2} \cdot s^{-3} \cdot A^{-2} (= V \cdot A^{-1})$
electric conductance**	siemens	S	$kg^{-1} \cdot m^{-2} \cdot s^{3} \cdot A^{2} (= A \cdot V^{-1} = \Omega^{-1})$
electric capacitance	farad	F	$A^{2} \cdot s^{4} \cdot kg^{-1} \cdot m^{-2} (= A \cdot s \cdot V^{-1})$
magnetic flux	weber	Wb	$kg \cdot m^{2} \cdot s^{-2} \cdot A^{-1} (= V \cdot s)$
inductance	henry	H	$kg \cdot m^{2} \cdot s^{-2} \cdot A^{-2} (= V \cdot A^{-1} \cdot s)$
magnetic flux density	tesla	T	$kg \cdot s^{-2} \cdot A^{-1} (= V \cdot s \cdot m^{-2})$
luminous flux	lumen	lm	$cd \cdot sr$
illumination	lux	lx	$cd \cdot sr \cdot m^{-2}$
frequency	hertz	Hz	s^{-1} (cycle per second)

**Recommended by CIPM, to be considered by CGPM in 1971.

UNITS USED WITH THE INTERNATIONAL SYSTEM

It is recognized that certain units which are not part of the SI are used so widely that it is impracticable to abandon them. The following units are therefore accepted for continued use with the International System:

Unit	Symbol
minute (of time)	min
hour	h
day	d
degree (of angle)	°
minute (of angle)	′
second (of angle)	″
liter (defined as 10^{-3} m^3)	l

USE OF NON-SI UNITS

As stated above, abrupt conversion to exclusive use of SI units by NBS authors might lead to considerable confusion and could significantly impair the ability of NBS to communicate efficiently with the scientific and technical community. Therefore, certain units which have been widely used because of their convenience in particular technical areas, and which are clearly defined relative to the SI, may be used advantageously in the transition period. Transition periods will vary for different fields of activity. In making decisions of this nature, the advice of NBS staff members who are expert in the relevant technical area will be taken into consideration. Whenever non-SI units are used, they should be defined in terms of the SI at least once in the paper. In the case of tables of data, parallel columns giving the results both in the non-SI and in SI units should be employed where this is practical. In some instances, it may be useful for graphs to carry double denotation of coordinates. It is useful to group these units in the following classes:

CLASS 1

Decimal Fractions and Multiples of SI Units Having Special Names

These units do not belong to the International System of Units. Their use is to be progressively discouraged. The time-scale implied by the word "progressively" need not, however, be the same for all these units, nor for any unit need it be the same in all fields of science. The intent here is continued leadership and promotion, without coercion. The following list is not exhaustive.

CLASS II

Other Units Now Exactly Defined in Terms of SI Units

These units do not belong to the International System of Units and their use is to be progressively discouraged *and eventually abandoned.*

Prefixes for Fractions and Multiples of SI Units

fraction	prefix	symbol	multiple	prefix	symbol
10^{-1}	deci	d	10	deka	da
10^{-2}	centi	c	10^{2}	hecto	h
10^{-3}	milli	m	10^{3}	kilo	k
10^{-6}	micro	μ	10^{6}	mega	M
10^{-9}	nano	n	10^{9}	giga	G
10^{-12}	pico	p	10^{12}	tera	T
10^{-15}	femto	f			
10^{-18}	atto	a			

Multiple prefixes, such as $\mu\mu$F for pF, should not be used.

Decimal Fractions and Multiples of SI Units Having Special Names

Physical Quantity	Name of Unit	Symbol for Unit	Definition of Unit
length	ångström	Å	10^{-10} m
length	micron(μ)*	μ	10^{-6} m$=\mu$m
area	barn	b	10^{-28} m^2
force	dyne	dyn	10^{-5} N
pressure	bar	bar	10^{5} N·m^{-2}
energy	erg	erg	10^{-7} J
kinematic viscosity	stokes	St	10^{-4} m^2·s^{-1}
viscosity	poise	P	10^{-1} kg·m^{-1}·s^{-1}
magnetic flux**	maxwell	Mx	10^{-8} Wb
magnetic flux density** (magnetic induction)	gauss	G	10^{-4} T
absorbed dose (ionizing radiation)	rad	rd	10^{-2} J·kg^{-1}

*The use of the word micron and the symbol μ for μm should be abandoned immediately.

**Note that units for these quantities are not dimensionally identical in the cgs system and in SI. For a full discussion of this point see C. H. Page, Am. J. Phys. 38, 421 (1970).

Units to be Eventually Abandoned

Physical Quantity	Name of Unit	Symbol for Unit	Definition of Unit (Exact)
length	inch	in	2.54×10^{-2} m
mass	pound (avoirdupois)	lb	0.453 502 37 kg
force	kilogram-force	kgf	9.806 65 N
pressure	atmosphere*	atm	101 325 N·m^{-2}
pressure	torr	Torr	(101 325/760) N·m^{-2}
pressure	conventional millimetre of mercury	mmHg	$13.5951\times980.665\times10^{-2}$ N·m^{-2}
energy	British Thermal Unit	BTU	1055.056 J
energy	kilowatt-hour	kWh	3.6×10^{6} J
energy	thermochemical calorie	cal_{th}	4.184 J
energy	I.T. calorie	cal_{IT}	4.1868 J
activity (radioactive nuclides)	curie*	Ci	3.7×10^{10} s^{-1}
exposure (x or γ rays)	roentgen*	R	2.58×10^{-4} C·kg^{-1}

*The CIPM has sanctioned the use of these units for a limited period of time.

CLASS III

Natural Units

Natural units are units that are tied directly to the properties of microscopic constituents of matter or to fundamental Lorentz invariant constants of nature. The use of natural units is acceptable. However, the author should state clearly which natural units are being used; such broad terms as "atomic units" should be avoided when there is danger of confusion.

Typical examples of natural units are:

Unit	Symbol
electronic charge	e
electron mass	m_e
proton mass	m_p
Bohr radius	a_0
electron radius	r_e
Compton wavelength of electron	λ_C
Bohr magneton	μ_B
nuclear magneton	μ_N
velocity of light	c
Planck's constant	h or $\hbar$
etc.	

CLASS IV

Units Defined in Terms of the Best Available Experimental Values of Certain Physical Constants

These units do not belong to the International System of Units. However, they have achieved universal acceptance because of convenience and conceptual advantages associated with their use. The factors for conversion of these units to SI Units are subject to change in the light of new experimental measurements of the constants involved. Whenever the use of these units adds clarity, they may be used, but central essential findings should be given in SI or in both. The following list is not exhaustive.

Units Defined in Terms of Certain Physical Constants

Physical Quantity	Name of Unit	Symbol for Unit	Conversion Factor
energy	electron volt	eV	$\approx 1.6021 \times 10^{-19}$ J
mass	unified atomic mass unit	u	$\approx 1.660\ 41 \times 10^{-27}$ kg
electric dipole moment	debye	D	$\approx 3.335\ 64 \times 10^{-30}$ A·m·s
distance (astronomical)	parsec	pc	$\approx 3.085\ 68 \times 10^{16}$ m
charge per mole	Faraday	F	$\approx 9.648 \times 10^{4}$ C/mol

Special Considerations:

1. The above discussion refers to numerical data that describe the conditions or results of an experiment in quantitative terms. No restrictions are placed on the units employed for general descriptive information that does not enter into calculations or expression of results. Thus it is acceptable to use such expressions as "a 200-inch telescope", "pressures in the range 1 to 10 atmospheres", and "at a pressure of about 1 mmHg". Likewise, commercial gage designations, drill size numbers, and other standard nomenclature may be used for descriptive purposes.

2. All integral powers, positive or negative, of SI units (including combinations of prefixes with SI units) are acceptable, either singly or in combination with other units. Note that exponents operate also on prefixes, as in cm^2, mm^3, which are 10^{-4} m^2, 10^{-9} m^3, not 10^{-2} m^2, 10^{-3} m^3.

In combinations such as meter-kelvin, use of the product dot (m·K) avoids confusion with "millikelvin". It is good practice to indicate *all* unit products with multiplication dots, since some unit symbols consist of more than one letter, e.g., Wb for weber, versus W·b for "watt-barn".

When a compound unit is formed by division of one unit by another, its symbol consists of the symbols for the separate units either separated by a solidus or multiplied by using negative powers (for example, m/s or $m \cdot s^{-1}$ for meter per second). In simple cases use of the solidus is preferred, but in no case should more than one solidus be included in a combination unless parentheses are inserted to avoid ambiguity. In complicated cases, negative powers should be used.

3. It is acceptable to use the Celsius temperature (symbol t) defined by the equation

$$t = T - T_0$$

where T is the thermodynamic temperature, expressed in kelvins, and $T_0 = 273.15$ K by definition. The Celsius temperature is in general expressed in degrees Celsius (symbol °C). The unit "degree Celsius" is thus equal to the unit "kelvin", and an interval or a difference of Celsius temperature may also be expressed in degrees Celsius.

4. In situations where the use of the symbol K for thermodynamic temperature would lead to confusion with other symbols, it may be replaced by °K.

5. Logarithmic measures such as pH, dB, and Np are acceptable.

6. On recommendation of the CIPM, the names of multiples and fractions of the kilogram are named by adding prefixes to the word *gram*.

7. The use of jargon such as temperature expressed in eV or energy in cm^{-1} should be avoided in print. In tables and graphs the units should always be consistent with the physical property that is specified. For example, if atomic term values are given in units of cm^{-1}, the column heading should be E/hc, not simply E.

8. Words and symbols should NOT be mixed; if mathematical operations are indicated, only symbols should be used. For example, one may write "joules per mole", "J/mol", "J/mol^{-1}", but not 'joules/mole', 'joules mol^{-1}', etc.

[1] A complete description of SI, together with guidelines for its implementation established by the International Committee on Weights and Measures, appears in The International System of Units, translated by C. H. Page and P. Vigoureaux, NBS Spec. Pub. 330.

[2] NBS Adapts International System of Units, NBS Tech. News Bull. 48, 61, (Apr. 1964).

[3] NBS Interpets Policy on SI Units, NBS Tech. News Bull. 52, 121, (June 1968).

NBS COOPERATES WITH MIT GROUP

Basic research in these complex times often requires a diversity of talents. A recent example is a project involving the Bureau, Massachusetts Institute of Technology (MIT), Stanford Linear Accelerator Center (SLAC), and diamond importer Harry Winston. The interrelationships, briefly, are these: A group at MIT, headed by Professor Louis Osborne and including Drs. Roy Schwitters and Dave Luckey, was investigating pion photoproduction from protons. They collaborated with an experimental group from SLAC, led by Professor Bert Richter, in order to continue these investigations at higher energies than had previously been possible. Their work required a high energy source of polarized Bremsstrahlung, the provision of which involved a rather perfect crystal of low atomic weight (enter Harry Winston), a means of assessing the "perfection" of the crystal, provided by apparatus and procedures developed at NBS by Dr. Richard Deslattes, and a high energy electron source, available at SLAC.

The goal of the MIT–SLAC collaboration was to test current theories concerning properties of particles that mediate the pion-nucleon interaction. Their approach required quantification of the photoproduction of π^+ mesons, particularly the dependence of this process on the polarization of Bremsstrahlung. The experiment involved production of coherent Bremsstrahlung [1] from an electron beam in a diamond, and passage of the Bremsstrahlung into liquid hydrogen to produce π^+ mesons. A charged particle spectrometer detected the mesons, providing information as to their momentum and angular distribution. The measurements made by the MIT–SLAC team had two effects: The technique of producing high energy polarized Bremsstrahlung was placed on a working basis, there having been some doubt within the nuclear fraternity as to the viability of the method when applied to extremely high electron energies; and their data provided significant additional limitations on the properties (quantum numbers) of the particle assumed to mediate pion photoproduction interactions at high energies.

Since minute changes in the orientation of a hypothetical perfect crystal would produce large changes in peak photon energy, considerable crystal perfection was required to assure even a moderately monochromatic beam. This experiment required homogeneity of lattice parameters on the order of a few parts per million, and crystal planes parallel to within a few microradians. For several reasons diamond is the preferred crystal, although sufficiently good specimens are not readily available. The search found its way to Harry Winston, Inc. of New York, one of the nation's largest diamond importers, and Mr. Ronald Winston, who personally screened many uncut diamonds, providing about a dozen stones in the two-to-five carat range for further study. After preliminary x-ray examination at NBS, two stones were purchased for cutting and further analysis. Specimens were prepared from these two stones by cutting both ends off the natural octahedral shape, using for the experiments the wafer (approximately 7 mm square by 0.5 mm thick) left after cutting.

A single axis, two crystal x-ray instrument [2] was used at NBS to characterize the diamonds. Similar devices are available in other laboratories, but the NBS device is relatively convenient to operate after minimal training. Dr. James A. Hammond of NBS ran some of the preliminary examinations, after which the remaining analyses were carried out largely by people from the high energy group.

In the NBS machine, x-rays from a conventional source are reflected from a reference crystal—silicon was used in this work—and are then reflected from or transmitted through the specimen before falling on either photographic film or a proportional counter. The specimen is mounted on a precision turntable, for alignment and rotation during analysis. Both uncut and cut specimens were analyzed topographically, the uniformity of the photographic image formed by the x-rays after reflection from one face or passage through the diamond giving an indication of the quality of the stone.[3] "Rocking curves," a plot of x-ray counts versus angular position of the specimen, were also run on many stones. These curves, recorded while the specimen is rotated at a constant rate from an initial orientation, provide information concerning "mosaic spread" and other imperfections in the crystal.

The two specimens, after final checking at NBS, were taken to SLAC for exposure to the electron beam. SLAC provided electrons with energies up to 16 GeV, and has a beam power of 120 kW. An interesting problem associated with beam exposure was that of making extremely small angular adjustments of the crystal in order to control the energy peak of the Bremsstrahlung. The problem, compounded by the fact that the sample was within a vacuum chamber, was solved by a stepping motor arrangement that provided angular increments of 2×10^{-5} radian. Over 80 data tapes were accumulated by the MIT–SLAC group during their time "on beam." While not all of the data have been analyzed, preliminary indications cast doubt on current theories of high energy photonuclear interactions, at least in their simplest forms.

[1] Diambrini, Palazzi, G., High-energy Bremsstrahlung and electron pair production in thin crystals, Rev. Mod. Phys. 40, 611–631 (July 1968).

[2] Deslattes, R. D., Single axis, two crystal x-ray instrument, Rev. Sci. Instr. 38, 815–820 (June 1967).

[3] Deslattes, R. D., and Paretzkin, B., A small set of reference crystals for double-crystal topography, J. Appl. Cryst. 1, 176–178 (Sept. 1968).

NATIONAL STANDARD NSRDS REFERENCE DATA SYSTEM NEWS

KEY VALUES FOR THERMODYNAMICS

In 1968 the Committee on Data for Science and Technology of the International Council of Scientific Unions (CODATA) appointed a Task Group on Key Values for Thermodynamics.* The principal objective of the Task Group is to prepare an internationally acceptable set of values of the basic thermodynamic properties of a number of chemical species, including the elements in both standard and monoatomic gaseous states, aqueous ions, and other related compounds.

The table below contains the Task Group's first set of proposed values for the standard enthalpies of formation at 298.15 K, $\Delta H_f^\circ{}_{298.15}$, the standard entropies at 298.15 K, $S^\circ{}_{298.15}$, and the standard enthalpy increments between 0 K and 298.15 K, $H^\circ{}_{298.15} - H^\circ{}_0$, of 32 species. By this announcement, the Task Group invites comments from thermodynamicists on the aptness of the proposed values. Any such comments will be gladly received by the Chairman of the Task Group, and will help in the formulation of a first set of recommended key values, to be published in approximately one year's time. Until then, any author who wishes to cite a value from the table below is requested to make clear that the value he cites is *tentative*. It should be carefully noted that the values now proposed are not fully consistent with the values in *any* previously published thermodynamic tables, for example, the "Technical Notes 270" of the National Bureau of Standards or "Termicheskie Konstanty Veshchestv" of the Academy of Sciences of the U.S.S.R. The achievement of consistency between the various thermodynamic tables is of course a long-term objective that the Task Group hopes to facilitate, but for some time to come, inconsistency between the Task Group's recommended values and values already tabulated in other series is inevitable.

The second set of species planned for consideration by the Task Group in the immediate future will include some of the following:

$S(g)$, $S(rh)$, $SO_2(g)$, $SO_4^{2-}(aq)$, $NH_3(g)$, $NH_4^+(aq)$, $NO_3^-(aq)$, $OH^-(aq)$, $Na(g)$, $Na(c)$, $Na^+(aq)$, $K(g)$, $K(c)$, $K^+(aq)$, $Li(g)$, $Li(c)$, $Li^+(aq)$, $Rb(g)$, $Rb(c)$, $Rb^+(aq)$, $Cs(g)$, $Cs(c)$, $Cs^+(aq)$, $F(g)$, $F_2(g)$, $HF(g)$, $F^-(aq)$.

The Task Group would be assisted if researchers who have completed measurements that are relevant to the Task Group's work on the second set of species would communicate their results to the Chairman of the Task Group in advance of publication.

In the tables below the usual definition of standard states are adopted. Relative atomic masses were taken as recommended by the Commission on Atomic Weights of IUPAC (1970). All data relate to the natural mixture of isotopic species; nuclear spin contributions are ignored. The following values of the fundamental physical constants were employed: gas constant $R = 8.314\,33 \pm 0.001\,20$ J·mol^{-1}·K^{-1}; constant relating wave number and energy $= 0.119\,6256 \pm 0.000\,0107$ J·m·mol^{-1}. The uncertainties in the table represent the Task Group's estimates of the overall uncertainties at a 95 percent confidence level.

Comments and suggestions should be sent to Professor S. Sunner, Thermochemistry Laboratory, Lund University, POB 740, 5220 07 Lund, Sweden.

[1] c = crystalline solid, l = liquid, g = ideal gas, aq = aqueous ideal solution. All phases are taken at a pressure of 101 325 Pa (formerly known as 1 standard atmosphere). Solutions are at unit concentration in mol·kg^{-1} (of solvent).

FOOTNOTES

a. Defined reference state.

b. Calculated, by direct summation over the energy levels, at the Institute for High Temperatures (U.S.S.R.) and the National Bureau of Standards (U.S.A.). The uncertainty given includes a contribution of 0.015 percent of the entropy due to the uncertainty in R.

c. Calculated using $D_0(O_2) = 41\,260 \pm 15$ cm^{-1} from Brix and Herzberg (1954), as-

*Present members: J. D. Cox, National Physical Laboratory, Teddington, U.K.; L. V. Gurvich, Institute for High Temperatures, Moscow, U.S.S.R.; D. M. Newitt, Imperial College of Science and Technology, London, U.K.; S. Sunner (Chairman), Thermochemistry Laboratory, Lund University, Lund, Sweden; D. D. Wagman, National Bureau of Standards, Washington, D.C. Consultants: C. B. Alcock, Imperial College of Science and Technology, London, U.K.; W. H. Evans, National Bureau of Standards, Washington, D.C.; V. Medvedev, Institute for High Temperatures, Moscow, U.S.S.R.; I. Wadsö Thermochemistry Laboratory, Lund University, Lund, Sweden.

Table of Proposed Key Values for Thermodynamics

Substance	State[1]	$\Delta Hf°_{298.15}$ kJ·mol^{-1}	Footnote	$S°_{298.15}$ J·mol^{-1}·K^{-1}	$H°_{298.15}-H_0°$ kJ·mol^{-1}	Footnote
O	g	249.17 ±0.10	c	160.946 ±0.020	6.728 ±0.003	b
O_2	g	0	a	205.037 ±0.033	8.682 ±0.004	b
H	g	218.002* ±0.006	d	114.604 ±0.015	6.197 ±0.002	b
H^+	aq	0	a	0	—	a
H_2	g	0	a	130.570 ±0.033	8.468 ±0.033	b
H_2O	l	−285.830 ±0.042	e	69.950 ±0.080	—	f
H_2O	g	−241.814 ±0.042	g	188.724 ±0.040	9.908 ±0.008	b
He	g	0	a	126.039 ±0.012	6.197 ±0.002	b
Ne	g	0	a	146.214 ±0.016	6.197 ±0.002	b
Ar	g	0	a	154.732 ±0.020	6.197 ±0.002	b
Kr	g	0	a	163.971 ±0.020	6.197 ±0.002	b
Xe	g	0	a	169.573 ±0.020	6.197 ±0.002	b
Cl	g	121.290 ±0.008	h	165.076 ±0.020	6.272 ±0.003	b
Cl^-	aq	−167.08 ±0.14	i	56.78 ±0.60	—	i
Cl_2	g	0	a	222.965 ±0.040	9.180 ±0.008	b
HCl	g	−92.31 ±0.13	i	186.786 ±0.033	8.640 ±0.004	b
Br	g	111.84 ±0.12	j	174.904 ±0.020	6.197 ±0.002	b
Br^-	aq	−121.50 ±0.17	k	83.3 ±1.3	—	k
Br_2	l	0	a	152.210 ±0.040	24.52 ±0.13	l
Br_2	g	30.91 ±0.11	l	245.350 ±0.054	9.724 ±0.012	b
HBr	g	−36.38 ±0.17	k	198.585 ±0.033	8.648 ±0.004	b
I	g	106.762 ±0.040	m	180.673 ±0.020	6.197 ±0.002	b
I^-	aq	−56.90 ±0.84	n	107.11 ±0.42	—	n
I_2	c	0	a	116.139 ±0.080	13.196 ±0.040	o
I_2	g	62.421 ±0.080	o	260.567 ±0.063	10.117 ±0.012	b
HI	g	26.36 ±0.80	n	206.480 ±0.040	8.657 ±0.006	b
N	g	472.68 ±0.40	p	153.189 ±0.020	6.197 ±0.002	b
N_2	g	0	a	191.502 ±0.025	8.669 ±0.003	b
C	c	0	a	5.74 ±0.12	1.050 ±0.020	q
C	g	716.67 ±0.44	r	157.988 ±0.020	6.535 ±0.006	b
CO	g	−110.53 ±0.17	s	197.556 ±0.032	8.673 ±0.008	b
CO_2	g	−393.51 ±0.13	t	213.667 ±0.040	9.364 ±0.008	b

*After preparation of the report a calculation error was found for this value. The appropriate value is 217.997kJ·mol^{-1}.

suming the products are o atoms in the ground state.

d. Calculated using $D_0(H_2) = 36\,118.3 \pm 1$ cm^{-1} from Herzberg (1970).

e. Enthalpy of formation of H_2O(l) from Rossini (1931, 1939) and King and Armstrong (1968).

f. Calculated from $S°_{298.15}H_2O$(g) with appropriate data for the entropies of expansion to saturation, correction to the real vapor, and vaporization, from Keenan, Keyes, Hill, and Moore (1969). See also Giaugue and Stout (1936).

g. Calculated from $\Delta H°_{f298.15}H_2O$(l) using data from Keenan, Keyes, Hill, and Moore (1969).

h. Calculated using $D_0(Cl_2) = 19\,997 \pm 1$ cm^{-1} based on Douglas, Møller, and Stoicheff (1963), LeRoy and Bernstein (1970), LeRoy (1970), and Sitterly (1970).

i. Enthalpy of formation of HCl(g) from Rossini (1932), Roth and Richter (1934), von Wartenberg and Hanisch (1932), Lacher, Kianpour, Oetting, and Park (1956), Faita, Longhi, and Mussini (1967), Cerquetti, Longhi, and Mussini (1968), and King and Armstrong (1970). Enthalpy of solution of HCl(g) from Gunn and Green (1963), Vanderzee and Nutter (1963), and Roth and Bertram (1937). Gibbs energy of solution from Bates and Kirschman (1919), Haase, Naas, and Thumm (1963), and Aston and Gittler (1955). Entropy of Cl^-(aq) from Bates and Bower (1954) and Greeley, Smith, Stoughton, and Lietzke (1960) on the Ag, AgCl, Cl^- electrode. See also Cerquetti, Longhi, and Mussini (1968).

j. Calculated using $D_0(^{79}Br, ^{81}Br) = 15\,893.1 \pm 2$ cm^{-1} based on Horsley and Barrow (1967) and Sitterly (1970). LeRoy (1970) recalculated $D_0(Br_2)$ from these data; his result is correct only if Horsley and Barrow missed many upper rotational levels of higher vibrational states in their interpretation of the absorption spectra.

k. Enthalpy of formation from Johnson and Sunner (1963), Johnson and Ambrose (1963), Sunner and Thorén (1964), Lacher, Casali, and Park (1956), and Howard and Skinner (1966). Enthalpy of solution of HBr(g) from Vanderzee and Nutter (1963), Roth and Bertram (1937), and Thomsen (1884). The entropy of Br^-(aq) from measurements on the Ag, AgBr, Br^- electrode by Hetzer, Robinson, and Bates (1962), Harned, Keston, and Donelson (1936), and Owen and Foering (1936), and from differences in the entropy of solution for the salt pairs KCl–KBr, CsCl–CsBr, AgCl–AgBr, and NaCl–NaBr·2H_2O.

l. From the specific heat and heat of vaporization measurements of Hildenbrand et al. (1958).

m. Calculated using $D_0(I_2) = 12\,440.9 \pm 1.1$ cm^{-1} from LeRoy (1970), Brown (1931), LeRoy and Bernstein (1970), and Sitterly (1970).

n. Enthalpy of formation of I^-(aq) from

Vorob'ev, Broier, and Skuratov (1966), Wu, Birkey, and Hepler (1963), and Howard and Skinner (1966). Entropy of $I^-(aq)$ from measurements on the Ag, AgI, I^- electrode by Hetzer, Robinson, and Bates (1964), Kortüm and Häussermann (1965), and Feakins and Watson (1963) and from differences in the entropy of solution for the salt pairs KCl–KI, CsCl–CsI, AgCl–AgI, and NaCl–NaI·$2H_2O$. Enthalpy of formation of HI(g) from Taylor and Crist (1941), Rittenberg and Urey (1934), Bright and Hagerty (1947), Murphy (1936), and Günther and Wekua (1931).

o. From the low-temperature specific heat data of Shirley and Giauque (1959) and vapor pressure data of Baxter, Hickey, and Holmes (1907), Baxter and Grose (1915), Gillespie and Fraser (1936), and Stern (1958).

p. Calculated from $D_0(N_2) = 78\,715 \pm 50$ cm^{-1} from Buttenbender and Herzberg (1935), Tanaka, Ogawa, and Jursa (1964), Tilford, Vanderslice, and Wilkinson (1965), and Sitterly (1970). See the discussion in Gaydon (1968).

q. Graphite is selected as the standard reference state for carbon. However, there is considerable variation in the measured values of the low-temperature heat capacity and entropy, depending upon the source and nature of the graphite sample. See DeSorbo (1955), DeSorbo and Nichols (1958), and DeSorbo and Tyler (1953). We have used the measurements of DeSorbo and Tyler on Acheson spectrosopic graphite, corresponding to the material used for the determination of the heat of formation of CO_2(g).

r. Calculated using $D_0(CO) = 89\,595 \pm 30$ cm^{-1} from Douglas and Møller (1955), assuming the products are $C(^3P_0)$ and $O(^3P_2)$.

s. Heat of formation of CO(g) from combustion measurements of Rossini (1931, 1939), Awbery and Griffiths (1933), and Fenning and Cotton (1933), and equilibrium measurements by Smith (1946), Neuman and Köhler (1928), Peters and Mobius (1958), and Meyer and Scheffer (1938).

t. Heat of formation from Prosen and Rossini (1944), Hawtin, Lewis, Moul, and Phillips (1966), Dewey and Harper (1938), Jessup (1938), and Lewis, Frisch, and Margrave (1965). Much of the uncertainty relates to the difference in the various samples of graphite that have been studied.

BIBLIOGRAPHY

Aston, J. G., Gittler, F. L., *J. Am. Chem. Soc.* **77**, 3173 (1955).

Awbery, J. H., Griffiths, E., *Proc. Roy. Soc.* (*London*) **A141**, 1 (1933).

Bates, R. G., Bower, V. E., *J. Res. Nat. Bur. Stand.* **53**, 283 (1954).

Bates, S. J., Kirschman, H. D., *J. Am. Chem. Soc.* **41**, 1991 (1919).

Baxter, G. P., Grose, M. R., *J. Am. Chem. Soc.* **37**, 1061 (1915).

Baxter, G. P., Hickey, C. H., Holmes, W. C., *J. Am. Chem. Soc.* **29**, 127 (1907).

Bright, N. F. H., Hagerty, R. P., *Trans. Faraday Soc.* **43**, 697 (1947).

Brix, P., Herzberg, G., *Can. J. Phys.* **32**, 110 (1954).

Brown, W. G., *Phys. Rev.* **38**, 709 (1931).

Buttenbender, G., Herzberg, G., *Ann. Physik.* [5], **21**, 577 (1935).

Cerquetti, A., Longhi, P., Mussini, T., *J. Chem. Eng. Data* **13**, 458 (1968).

Commission on Atomic Weights of I.U.P.A.C., *Pure Appl. Chem.* **21**, 95 (1970).

DeSorbo, W., *J. Chem. Phys.* **23**, 1970 (1955); *J. Am. Chem. Soc.* **77**, 4713 (1955).

DeSorbo, W., Nichols, G. F., *J. Phys. Chem. Solids* **6**, 352 (1958).

DeSorbo, W., Tyler, W. W., *J. Chem. Phys.* **21**, 1660 (1953).

Dewey, P. H., Harper, D. R., *J. Res. Nat. Bur. Stand.* **21**, 457 (1938).

Douglas, A. E., Møller, C. K., *Can. J. Phys.* **33**, 125 (1955).

Douglas, A. E., Møller, C. K., Stoicheff, B. P., *Can. J. Phys.* **41**, 1174 (1963).

Faita, G., Longhi, P., Mussini, T., *J. Electrochem. Soc.* **114**, 340 (1967).

Feakins, D., Watson, P., *J. Chem. Soc.* **1963**, 4686.

Fenning, R. W., Cotton, F. T., *Proc. Roy. Soc.* (*London*) **A141**, 17 (1933).

Gaydon, A. G., *Dissociation Energies and Spectra of Diatomic Molecules*, 3d ed. Chapman and Hall, London, 1968.

Giauque, W. F., Stout, J. W., *J. Am. Chem. Soc.* **58**, 1144 (1936).

Gillespie, L. J., Fraser, L. H. D., *J. Am. Chem. Soc.* **58**, 2260 (1936).

Greeley, R. S., Smith, W. T., Stoughton, R. W., Lietzke, M. H., *J. Phys. Chem.* **64**, 652 (1960).

Gunn, S. R., *U.S. Atomic Energy Comm. Rept.* UCRL 7992 (1964).

Gunn, S. R., Green, L. G., *J. Chem. Eng. Data* **8**, 180 (1963).

Günther, P., Wekua, K., *Z. Physik. Chem.* **A154**, 193 (1931).

Haase, R., Naas, H., Thumm, H., *Z. Physik. Chem.* (*Frankfort*) (*N.F.*) **37**, 210 (1963).

Harned, H. S., Keston, A. S., Donelson, J. G., *J. Am. Chem. Soc.* **58**, 989 (1936).

Hawtin, P., Lewis, J. B., Moul, N., Phillips, R. H., *Trans. Roy. Soc.* (*London*) **A261**, 67 (1966).

Herzberg, G., *J. Mol. Spectroscopy* **33**, 147 (1970).

Hetzer, H. B., Robinson, R. A., Bates, R. G., *J. Phys. Chem.* **66**, 1423 (1962).

Hetzer, H. B., Robinson, R. A., Bates, R. G., *J. Phys. Chem.* **68**, 1929 (1964).

Hildenbrand, D. L., Kramer, W. R., McDonald, R. A., Stull, D. R., *J. Am. Chem. Soc.* **80**, 4129 (1958).

Horsley, T. A., Barrow, R. F., *Trans. Faraday Soc.* **63**, 32 (1967).

Howard, P. B., Skinner, H. A., *J. Chem. Soc.* **1966**, 1536.

Jessup, R. S., *J. Res. Nat. Bur Stand.* **21**, 475 (1938).

Johnson, W. H., Ambrose, J. R., *J. Res. Nat. Bur. Stand.* **67A**, 427 (1963).

Johnson, W. H., Sunner, S., *Acta Chem. Scand.* **17**, 1917 (1963).

Keenan, J. H., Keyes, F. G., Hill, P. G., Moore, J. G., *Steam Tables.* John Wiley, New York, 1969.

King, R., Armstrong, G. T., *J. Res. Nat. Bur. Stand.* **72A**, 113 (1968).

King, R., Armstrong, G. T., *J. Res. Nat. Bur. Stand.* (1970, in press).

Kortüm, G., Häussermann, W. F., *Ber. Bunsengs. Physik. Chem.* **69**, 594 (1965).

Lacher, J. R., Casali, L., Park, J. D., *J. Phys. Chem.* **60**, 607 (1956).

Lacher, J. R., Kianpour, A., Oetting, F., Park, J. D., *Trans. Faraday Soc.* **52**, 1500 (1956).

LeRoy, R. T., *Chem. Phys. Letters* **5**, 42 (1970).

LeRoy, R. T., Bernstein, R. B., *J. Chem. Phys.* **52**, 2678, 3869 (1970).

Lewis. D. C., Frisch, M. A., Margrave, J. L., *Carbon* **2**, 431 (1965).

Meyer, G., Scheffer, F. E. C., *Rec. trav. chim.* **57**, 604 (1938).

Murphy, G. M., *J. Chem. Phys.* **4**, 344 (1936).

Neumann, B., Köhler, G., *Z. Elektrochem.* **34**, 218 (1928).

Owen, B. B., Foering, L., *J. Am. Chem. Soc.* **58**, 1575 (1936).

Peters, H., Mobius, H. H., *Z. Physik. Chem.* **209**, 298 (1958).

Prosen, E. J., Rossini, F. D., *J. Res. Nat. Bur. Stand.* **33**, 439 (1944).

Rittenberg, D., Urey, H. C., *J. Chem. Phys.* **2**, 106 (1934).

Rossini, F. D., *J. Res. Nat. Bur. Stand.* **6**, 1 and 36 (1931).

Rossini, F. D., *J. Res. Nat. Bur. Stand.* **9**, 679 (1932).

Rossini, F. D., *J. Res. Nat. Bur. Stand.* **22**, 407 (1939).

Roth, W. A., Bertram, A., *Z. Elektrochem.* **43**, 376 (1937).

Roth, W. A., Richter, H., *Z. Physik. Chem.* **A170**, 123 (1934).

Shirley, D. A., Giauque, W. F., *J. Am. Chem. Soc.* **81**, 4778 (1959).

Sitterly, C. M., National Bureau of Standards, Washington, D.C. (Private communication).

Smith, R. P., *J. Am. Chem. Soc.* **68**, 1163 (1946).

Stern, T. H., Ph. D. Thesis, University of Washington, 1958.

Sunner, S., Thorén, S., *Acta Chem. Scand.* **18**, 1328 (1964).

Tanaka, Y., Ogawa, M., Jursa, A. S., *J. Chem. Phys.* **40**, 3690 (1946).

Taylor, A. H., Crist, K. H., *J. Am. Chem. Soc.* **63**, 1377 (1941).

Thomsen, J., Thermochemische *Untersuchungen.* J. Barth, Leipzig, 1884.

Tilford, S. G., Vanderslice, J. T., Wilkinson, P. G., *Astrophys. J.* **142**, 1203 (1965).

Vanderzee, C. E., Nutter, J. D., *J. Phys. Chem.* **67**, 2521 (1963).

Vorob'ev, A. F., Broier, A. F., Skuratov, S. M., *Dokl. Akad Nauk SSSR* **173**, 385 (1966).

von Wartenberg, H., Hanisch, K., *Z. Physik. Chem.* **A161**, 413 (1932).

Wu, C., Birkey, M. M., Hepler, L. G., *J. Phys. Chem.* **67**, 1202 (1963).

FIPS NOTES

VOCABULARY FOR INFORMATION PROCESSING

The Office of Management and Budget* has approved the use of the American National Standard Vocabulary for Information Processing (X3.12–1970) as a common reference within the Federal Government. Details concerning the development and use of the Vocabulary are contained in Federal Information Processing Standards Publication 11 (FIPS PUB 11) entitled Vocabulary for Information Processing.

The Vocabulary, containing over 1200 terms and definitions, will replace the OMB's Automatic Data Processing Glossary that was printed in 1962 as a basic reference document. The Vocabulary was developed by ANSI Committee X3K5 (formerly X3.5), which is chaired by Martin H. Weik of the U.S. Army Information Systems Office. This edition of the Vocabulary will be the last of its kind in that future versions will be in the form of dictionaries. The dictionary will describe more than one use of a term, whereas a vocabulary prescribes the use of a term.

The ANSI Vocabulary was reviewed and endorsed by Federal Information Processing Standards Task Group 5, Vocabulary, chaired by Miss Josephine Walkowicz of the NBS Office of Computer Information. Additional Government requirements for terms and definitions will be processed by the Task Group and submitted to ANSI for inclusion in the coming version of the Information Processing Dictionary.

*Formerly the Bureau of the Budget.

Federal Government organizations may obtain copies of the Vocabulary from the General Services Administration, Specifications Activity, Printed Materials Supply Division, Building 197, Naval Weapons Plant, Washington, D.C. 20402, at a cost of $1 per copy. Orders should refer to FIPS PUB 11, Vocabulary for Information Processing. Others may obtain copies from the American National Standards Institute, 1430 Broadway, New York, N.Y. 10018, at $6 per copy. Refer to X3.12–1970, Vocabulary for Information Processing.

NEW ISO PRESIDENT

On January 1, 1971, Francis L. LaQue, Canadian-born President of the American National Standards Institute (ANSI), began a three-year term of office as President of ISO, succeeding Faruk A. Sunter, President of the Turkish Standards Institution. Mr. LaQue is consultant to the International Nickel Company with which he has been associated since 1927.

As a director and President of ANSI, Mr. LaQue has been a forceful advocate in expanding and strengthening the participation of the United States in the work of ISO and its affiliated organization, the International Electrotechnical Commission (IEC).

ADP PRODUCT INFORMATION RESOURCES

The Center's Office of Computer Information (OCI) seeks to provide single-point-of-contact technical information services on all aspects of the computer sciences and technology. In its holdings are publications that present descriptive information in compact form on currently available computer systems and computer-related equipment. Most of these reference services are in looseleaf format for convenient insertion of revisions and additions issued periodically to reflect the current state of the market. Listed below are several of the more useful ADP product information sources that OCI makes available to the computer community, both for personal consultation and for OCI staff response to requests for specific information.

- Auerbach Info, Inc., Auerbach Computer Technology Reports

  Computer Notebook International, 2 vols., updated monthly, contains features and limitations of large-scale U.S. computer systems and of computer systems manufactured outside the United States.

  Data Communication Reports, 3 vols., updated bimonthly, contains individual reports on communications terminals and processing equipment, and common carrier facilities.

  Data Handling Reports, 3 vols., updated bimonthly, contains descriptions of equipment used for capturing data at its source.

  Graphic Processing Reports, 2 vols., updated bimonthly, contains descriptions of information storage and retrieval systems, microform equipment, plotters, com-

puter-driven displays and phototypesetters.

Minicomputers, 3 vols., updated monthly, contains current awareness reports on minicomputers and process control computers.

Standard EDP Reports, 8 vols., updated monthly, contains detailed hardware and software analyses of major U.S. computer systems.

Time-Sharing Reports, 2 vols., updated bimonthly, contains reports on state of the time-sharing art, languages, and applications.

- Berkeley Enterprises, Inc., *Computers and Automation*, published monthly. The June issue is an Annual Directory and Buyers' Guide to organizations, products, services, programming languages, and computer characteristics.
- Business Press International, *Business Automation*, published monthly. The September issue is an annual directory of manufacturers of computers and related equipment.
- Datapro Research Corp., Inc., *Datapro 70. The EDP Buyers' Bible, 1970*, updated monthly, is a compilation of information necessary for selection of hardware and software now on the market.
- Digital Applications, Inc., *Mini-Computers: A Study in Opportunity*, 2 vols., November 1969, plus three supplements published to date describing minicomputers configured for three specific applications.
- Keydata Corp.

The Computer Display Review, 3 vols., updated three times a year, contains hardware descriptions, prices and delivery schedules for current display equipment, plus reprints of significant articles on display hardware, software, applications, and trends.

Computer Characteristics Review, reissued completely three times a year, contains a tabular presentation of characteristics of digital computers and peripheral devices commercially available, with prices for typical configurations.

A compilation of over 150 profiles of the above and other periodic computer information sources is available to personnel of government agencies upon request to the Office of Computer Information, Center for Computer Sciences and Technology, National Bureau of Standards, Washington, D.C. 20234, (301) 921–3517.

GRAPHIC REPRESENTATIONS FOR ASCII CONTROL CHARACTERS

ANSI Subcommittee X3L2 (formerly X3.2), Character Codes, has forwarded to X3 a proposed standard for the Graphic Representations of the Control Characters of ASCII (American Standard Code for Information Interchange, FIPS PUB 1).

Generally, control characters are not printed in most applications. (Control characters are those characters used to control communications and formats, and to separate information elements.) However, in certain situations it is desirable to display graphically all the characters in a given bit string. Also, standard symbols are needed for use on key tops on devices having keyboards using the control characters. The proposed standard provides for two alternative sets of representations, i.e., pictorials (symbols) and alphanumerics (letters and numbers). The proposed stand-

STANDARD GRAPHIC REPRESENTATIONS

Code position	Character	Pictorial repr.	Alphanumeric repr.
0/0	NUL	□	NU
0/1	SOH	⌜	SH
0/2	STX	⊥	SX
0/3	ETX	⌟	EX
0/4	EOT	↘	ET
0/5	ENQ	⊠	EQ
0/6	ACK	✓	AK
0/7	BEL	⌓	BL

Code position	Character	Pictorial repr.	Alphanumeric repr.
0/8	BS	⟍	BS
0/9	HT	⩾	HT
0/10	LF	☰	LF
0/11	VT	⩛	VT
0/12	FF	⩔	FF
0/13	CR	⩽	CR
0/14	SO	⊗	SO
0/15	SI	⊙	SI

Code position	Character	Pictorial repr.	Alphanumeric repr.
1/0	DLE	⊟	DL
1/1	DC1	◷	D1
1/2	DC2	◶	D2
1/3	DC3	◵	D3
1/4	DC4	◴	D4
1/5	NAK	✓	NK
1/6	SYN	⎍	SY
1/7	ETB	⊣	EB

ard representations are shown in figure 1; a legend is provided to the figure.

Copies of the proposed standard may be obtained from the Business Equipment Manufacturers Association, BEMA/STDS, 1828 L Street NW., Washington, D.C. 20036. Refer to document X3L2/987.

THE MANAGEMENT OF INFORMATION AND KNOWLEDGE

The eleventh annual meeting of the Committee on Science and Astronautics, U.S. House of Representatives, and the Panel on Science and Technology was held in January 1970 with the theme "The Management of Information and Knowledge."

The impact upon society caused by the rapid development of the computer and the revolution in communications technology was closely examined in papers presented by 10 eminent educators, sociologists, and scientists from the United States and four foreign countries.

Keynote addresses were presented by McGeorge Bundy, President of the Ford Foundation, and Earl Warren, Chief Justice of the United States Supreme Court, retired. Moderator for the Panel was Daniel Bell, Professor of Sociology, Harvard University, and Chairman, Commission of the Year 2000, Academy of Arts and Sciences. The following were guest panelists:

Herman Kahn, Director, Hudson Institute, Croton, N.Y.

Stafford Beer, Development Director, International Publishing Corporation

Daniel J. Boorstin, Director, The National Museum of History and Technology, Smithsonian Institution

Paul Armer, Director, Computation Center, Stanford University

Osmo A. Wiio, Professor of Organization, Theory and Personnel Management, Helsinki University, Finland

George Kozmetsky, Dean, College of Business Administration and Graduate School of Business, University of Texas.

Thomas F. Green, Director, Educational Policy Research Center, Syracuse University, New York

Fernando Garcia-Roel, Rector, Instituto Technologico y de Estudios Syperiores de Monterrey, N.L., Mexico

Ioan D. Stancescu, Professor, Bucharest Technical University, and Counselor, National Council of Scientific Research, Rumania

L. Harvey Poe, Jr., Partner, law firm of Howard & Poe, Washington, D.C.

The papers presented during the three day panel dealt with the increasing complexity of the world, the proliferation of new data, increasing power of computers, new means of managing information and controlling the vast technology which is now available. Because of the relevance and importance of these matters to the Congress, the American public, and the scientific and academic communities worldwide, these papers have been published by the Committee on Science and Astronautics in the form of a report entitled *The Management of Information and Knowledge*. This is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 at 60 cents a copy. (Catalog No. Y4.SCI2:IN 3)

Code position	Character	Pictorial repr.	Alphanumeric repr.
1/8	CAN		CN
1/9	EM		EM
1/10	SUB		SB
1/11	ESC		EC
1/12	FS		FS
1/13	GS		GS
1/14	RS		RS
1/15	US		US

Code position	Character	Pictorial repr.	Alphanumeric repr.
2/0	SP		SP
7/15	DEL		DT

Legend

Control Characters

NUL	Null
SOH	Start of Heading (CC)
STX	Start of Text (CC)
ETX	End of Text (CC)
EOT	End of Transmission (CC)
ENQ	Enquiry (CC)
ACK	Acknowledge (CC)
BEL	Bell (audible or attention signal)
BS	Backspace (FE)
HT	Horizontal Tabulation (punched card skip) (FE)
LF	Line Feed (FE)
VT	Vertical Tabulation (FE)
FF	Form Feed (FE)
CR	Carriage Return (FE)
SO	Shift Out
SI	Shift In
DLE	Data Link Escape (CC)
DC1	Device Control 1
DC2	Device Control 2
DC3	Device Control 3
DC4	Device Control 4 (Stop)
NAK	Negative Acknowledge (CC)
SYN	Synchronus Idle (CC)
ETB	End of Transmission Block (CC)
CAN	Cancel
EM	End of Medium
SUB	Substitute
ESC	Escape
FS	File Separator (IS)
GS	Group Separator (IS)
RS	Record Separator (IS)
US	Unit Separator (IS)
DEL	Delete [1]

Graphic Character

SP	Space (Normally Non-Printing)

NOTE: (CC) Communication Control
(FE) Format Effector
(IS) Information Separator

[1] In the strict sense, DEL is not a control character.

CONFERENCE & PUBLICATION *Briefs*

25TH ANNUAL CALORIMETRY CONFERENCE HELD

The Silver Anniversary of the Annual Calorimetry Conference was held October 19–22, 1970, at NBS. The Conference covered such areas of calorimetry as theoretical aspects, instrumentation, and the results of calorimetric measurements. The application of calorimetry to biological problems was one of the major subjects of discussion at the Conference.

Professor S. Sunner of the University of Lund, Sweden, opened the technical sessions with the Huffman Memorial Lecture (in memory of the founder of the Conference, Hugh M. Huffman). The lecture was a historical tribute to the organization's 25th anniversary, entitled Developments in Calorimetry Over Thirty-Five Years, 1945–1980. Professor Sunner stated that most calorimetric techniques used today are not new but merely variations of older techniques, some developed more than 100 years ago. Newly developed materials, and improvement in the purity of materials, are important developments that will lead to advances in calorimetric measurements.

Nine invited papers on calorimetric applications to biological problems, models of calorimeters, and calculations for isoperibol calorimeters were presented at the first day's general session. Papers discussing heater lead problems of calorimeters, and aneroid calorimeters were also given; two papers commenting on the use of additional shielding in calorimeters finished the day's general session.

A concurrent biological session discussed such topics as the application of calorimetry to biological problems, the use of reaction calorimetry in biochemistry and biology, calorimetry's use in determining sites of proton and metal binding in nucleic acids, the calorimetric investigation of metal binding with macrocylic polydentate molecules, the calorimetric investigation of metal binding in amino acids and polypeptides, and the calorimetry of binding biochemically useful phosphates to macromolecules. Three papers on water were presented at an evening session: the intermolecular nature of water, a thermodynamic analysis of the ionization of amines in water, and the hidden dimension in water.

Two invited papers discussing the use of an AC bridge for temperature measurement and quartz thermometry initiated the next day's sessions. Dr. Lewis M. Branscomb, Director of the National Bureau of Standards, presented the banquet address on the Bureau's delegated responsibility to perform a comprehensive and rational evaluation of the Nation's alternative courses of action in adopting the metric system of measurement. He discussed the increasing use of the metric system in the U.S. and the procedures involved in the study.

The Conference concluded with six discussion groups on: general problems, nomenclature, solution calorimetry, fluorine thermochemistry, vapor pressure and temperature conversion, and heat capacity. The groups exchanged ideas informally in an attempt to solve some of their common problems.

SCHEDULED NBS-SPONSORED CONFERENCES

Each year NBS sponsors a number of conferences covering a broad range of topics in science and technology. The conferences listed below are either sponsored or cosponsored by NBS and will be held at the Bureau's Gaithersburg, Md., facility unless otherwise indicated. These conferences are open to all interested persons unless specifically noted. If no other address is given, inquiries should be sent to the person indicated below in care of Special Activities Section, Room A600, Administration Building, National Bureau of Standards, Washington, D.C. 20234.

Second National Conference on Roofing Technology. Mar. 22–23. Cosponsor: National Roofing Contractors Association. Contact: William C. Cullen (NBS Building Research Division).

Flow—Its Measurement and Control in Science and Industry. May 10–14. Cosponsors: American Institute of physics; American Society of Mechanical Engineers; Instrument Society of America. Contact: V. J. Giardina, Instrument Society of America, 400 Stanwix Street, Pittsburgh, Pa. 15222. To be held in Pittsburgh, Pa.

Fourth Joint Meeting of Operations Researchers. May 24–26. Cosponsors: College on Logistics of the Institute for Management Sciences (TIMS); Mathematical Society of America; American Society for Cybernetics; American So-

ciety for Public Administration; Association for Computing Machinery; Operations Research Society of America. Contact: Lloyd Burden (NBS Technical Analysis Division).

Summer Symposium in Analytical Chemistry. June 16–18. Cosponsor: American Chemical Society (Division of Analytical Chemistry). Contact: R. A. Durst (NBS Analytical Chemistry Division).

Fifth Symposium on Temperature Measurement and Control in Science and Industry. June 21–24. Cosponsors: American Institute of Physics; Instrument Society of America. Contact: H. H. Plumb (NBS Heat Division).

NBS Measurement Seminars, 1971 Series. Two- to four-day courses on measurement and calibration problems. Attendance limited. See September 1970 *Technical News Bulletin* for detailed information.

INDEX TO SELECTED STATISTICAL JOURNALS

An Author and Permuted Title Index to Selected Statistical Journals by Brian L. Joiner, N. F. Laubscher, Eleanor S. Brown, and Bert Levy, NBS Special Publication 321 [1] ($5.75, SD Catalog No. C13.10:321), provides an index to the following seven statistical journals, including all articles, notes, queries, corrigenda, and obituaries appearing in the indicated issues: *Annals of Mathematical Statistics* (1961–1969), *Biometrics* (1965–1969, No. 3), *Biometrika* (1951–1969), *Journal of the American Statistical Association* (1956–1969), *Journal of the Royal Statistical Society*, Series B (1954–1969, No. 2), *South African Statistical Journal* (1967–1969, No. 2), and *Technometrics* (1959–1969). For the first six named journals, this index takes up where the last cumulative index leaves off; for *Technometrics*, all issues through 1969 are covered.

The publication has three sections: a permuted title index, an author index, and a bibliographical listing. The permuted title index can be used to retrieve an article if any part of its title is known, or to find all articles whose titles include a particular word or phrase. This index should consequently serve many of the functions of a conventional subject index. In the author index, every article is listed under each of its authors' names, the name being followed by as much of the title as fits on one line. The third section is a chronological listing of the tables of contents of the seven journals for the included years.

PORTLAND CEMENT PASTES AND MORTARS

Exploratory Studies of Early Strength Development in Portland Cement Pastes and Mortars by R. L. Blaine and L. A. Tomes, NBS Building Science Series 28 (25 cents, SD Catalog No. C13.29/2:28), is a report [1] on the plasticity as well as the rate of stiffening of cement pastes, mortars, and concretes determined by means of viscometers, penetrometers, soniscopes, and several other devices. Conventional vane-shear apparatus was also used, but with results that were not adequately coherent. The paper, however, describes a modified vane-shear apparatus that proved satisfactory to measure the shear resistance, and increase in shear resistance with time as the cements hardened, of neat cement pastes of normal consistency and 1:2.75 (cement to sand) mortars of standard consistency. In all cases the measurements indicate what appear to be three distinct phases in the setting and early hardening process, as postulated by various authors. The rate of increase of shear resistance as well as the duration of the different phases differed with the different cements. The results were analyzed in terms of the various proposed theories of cement hardening.

PHOTONUCLEAR REACTIONS

Photonuclear Reactions, NBS Monograph 118 [1] (50 cents, SD Catalog No. C13.44:118) edited by Evans Hayward, is a review paper of photonuclear reactions in the approximate energy range of 10 to 30 MeV. Various sum rules are discussed and applied to experimental data; and several different theories are described and their predictions compared with experiment. After a chapter on fundamentals, the subject is discussed under the following heads: scattering and absorption of photons by nuclei, photonuclear experiments, heavy nuclei and the hydrodynamic model, light nuclei and the independent particle model, the decay of the dipole state, isobaric spin and photonuclear reactions. As often as possible, the author points out open questions and discrepancies.

PRECISION MEASUREMENT AND CALIBRATION

Precision Measurement and Calibration: Electricity—Radio Frequency, Arthur J. Estin, editor, NBS Special Publication 300, Volume 4 [1] ($5.50, SD Catalog No. C.13.10:300/vol. 4), is one of a series that updates and expands NBS Handbook 77, a three-volume collection of previously published writings by NBS authors on precision measurement and calibration.

The ten sections into which the volume has been divided represent an attempt to categorize the problems in radio metrology. The first three (Power, Voltage and Current, Electromagnetic Fields and Antennas) are all fundamental, sinusoidal, and active in a generalized Thevenin sense, while sections 4 and 5 (Radar and Baseband Pulses, Noise), through also active, are nonsinusoidal and somewhat less fundamental. The next two (Attenuation and Phase, Impedance) are sinusoidal, but are derived quantities and are Thevenin passive.

The last three sections (Radio Frequency Materials, Quasi-Optics and Millimeter Waves, Components and Subsystems) go from the conceptually simple idea of a "quantity" to physical and technological utilization of more than one quantity in an application.

RADIOLOGICAL SAFETY FOR PARTICLE ACCELERATORS

NBS Handbook 107, *Radiological Safety in the Design and Operation of Particle Accelerators*[1] (30 cents, SD Catalog No. C13.11:107), by the American National Standards Institute Subcommittee N43–4, contains recommended safety standards for the design and operation of particle accelerators. Recognizing that design and operational requirements are inseparable elements of safety, the Subcommittee devoted the major sections of the handbook to radiation protection design criteria, operational health physics, radiation measurements, and dose assessment.

The standard was developed following the procedures of the American National Standards Institute (ANSI), with participation of individuals from many interested laboratories. The National Bureau of Standards serves as Secretariat of ANSI Committee N43, which was responsible for developing the standard. In addition, NBS provides the publication outlet for standards produced by this Committee.

[1] Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Order by SD Catalog Number for the price indicated.

1970 ROSA AND STRATTON AWARDS

On October 20, 1970, Dr. Lewis M. Branscomb, NBS Director, presented the 1970 Edward B. Rosa Award to Paul Reece Achenbach for "outstanding achievement in the development of engineering standards" and the Samuel W. Stratton Award to Robert P. Madden for "imaginative use of a high-energy accelerator to open a new and rewarding field of atomic structure research." Each Award consists of a bronze plaque and a $1500 honorarium.

The Rosa Award, first given for 1964, is named for Dr. Edward B. Rosa, a member of the Bureau's original staff and its first Chief Physicist. Throughout his career, Dr. Rosa was active in the development of standards of practice and made important original contributions of fundamental standards in the fields of electricity and photometry. The Award gives recognition to outstanding accomplishments in the field of standards of practice—the standards by which industry judges its operations, its production processes, and the quality of its products.

Mr. Achenbach, Chief of the Sensory Environment Branch in the Building Research Division, was presented the Rosa Award in recognition of over 30 years of engineering and research activities in the field of building science. Throughout this time he has contributed to a wide range of building standards and practice through generation of new technical information, development of the performance concept in testing procedures, and leadership on committees and task groups of national and international standards organizations. Mr. Achenbach has urged and promoted broader standards activity in developing standard test procedures on human factors in air-conditioned buildings, interdisciplinary programs to improve the urban environment, and the application of computer technology to determination of energy requirements and heating and cooling loads for buildings. He is the Department of Commerce representative on the U.S. National Committee of the International Institute of Refrigeration, a member of the U.S. National Committee of the International Council for Building Research, Studies and Documentation, and is active in technical committees on refrigeration established by the International Standards Organization.

The Stratton Award is named for the first Director of the National Bureau of Standards. In 1901, Dr. Samuel Wesley Stratton set about to organize NBS as a unique scientific institution. During his 21-year tenure of office, he firmly established the Bureau's position in the scientific and industrial community. This Award is given to recognize outstanding scientific or engineering achievements in support of the NBS mission.

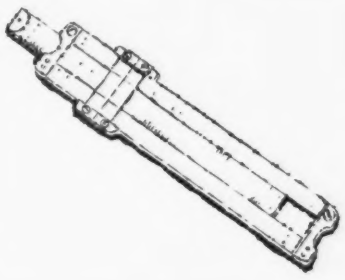
The recipient of the Stratton Award, Dr. Madden, is Chief of the Far Ultraviolet Physics Section in the Optical Physics Division. Since joining the Bureau in 1960, Dr. Madden's experiments in atomic physics have produced hitherto unobserved data on continuum interactions in atoms. His findings have had significant application in understanding stellar atmospheres and have stimulated scientific groups in other parts of the world to undertake a similar series of studies in what is now recognized as one of the decade's most important developments in atomic physics. In 1964, Dr. Madden was corecipient of a Department of Commerce Silver Medal for work in applying the NBS synchrotron to absorption studies in the vacuum ultraviolet region and for the discovery of important new data on the high-lying energy states in the rare gases. The Washington Academy of Sciences presented him an achievement award in 1966 for his investigations of the behavior of rare gas atoms under the influence of photons with wavelengths of from 70 to 600 Å.

BRANSCOMB (*From p. 14*)

formation needed for the evaluation is not there.[2]

If any of you have not read the "Recommendations for Reporting Experimental Results" in the final pages of the Taylor, Parker, and Langenberg review, I urge you to do so. They sum it up in one sentence: "The experimenter should ask himself, 'Have I provided enough information in a sufficiently clear manner so that ten years hence my result can be updated in light of any new information or data which may become available?'" For if a paper meets that test, it will also meet the test of suitability for evaluation, which is the price of a finite weight factor in any statistical averaging with other data of like kind.

A world obsessed with the pervasive effect of rapid change might take some solace from this Conference. For while mankind has abused nature—with industrial, agricultural and human destruction and contamination and may find nature fickle, or even hostile as a result, physicists who search for her truths with delicate precision find her steadfast and true.



We have learned that the deeper we wish to probe, the more gentle we must be. By listening carefully, looking closely, and touching ever so gently, we can slowly peel away the layers of our ignorance. Our faith in the rationality of the natural order is reinforced; our concern for mankind's irrationality heightened. Ours is not a clumsy or utilitarian art, but the highest refinement of scientific skill in both its experimental and theoretical aspects. By asking the most fundamental questions of science we generate and refine a system of practically realizable measurement units and tools in terms of which to probe all physical phenomena. This continually evolving system then provides the basis for the development of all scientific knowledge, without which we cannot live in harmony with nature.

[1] Taylor, B. N., Parker, W. H., and Langenberg, D. N., Determination of e/h, using macroscopic quantum phase coherence in superconductors: Implications for quantum electrodynamics and the fundamental physical constants, Rev. Mod. Phys. 41, No. 3, 375–496 (July 1969).

[2] Branscomb, L. M., The misinformation explosion: Is the literature worth reviewing?, Sci. Res. 3, No. 11, 49–52 (May 1968).

PUBLICATIONS of the National Bureau of Standards*

PERIODICALS

Technical News Bulletin, Annual Subscription: Domestic, $3; foreign, $4. Single copy, 30 cents. Available on a 1-, 2-, or 3-year subscription basis. SD Catalog No. C13.13:54.

Journal of Research of the National Bureau of Standards

Section A. Physics and Chemistry. Issued six times a year. Annual subscription: Domestic, $9.50; foreign, $11.75. Single copy price varies. SD Catalog No. C13.22/sec.A:74.

Section B. Mathematical Sciences. Issued quarterly. Annual subscription: Domestic, $5; foreign, $6.25. Single copy, $1.25. SD Catalog No. C13.22/sec.B:74.

Section C. Engineering and Instrumentation. Issued quarterly. Annual subscription: Domestic, $5; foreign, $6.25. Single copy, $1.25. SD Catalog No. C13.22/sec.C:74.

CURRENT ISSUE OF THE JOURNAL OF RESEARCH

J. Res. Nat. Bur. Stand. (U.S.), **75A1** (*Phys. and Chem.*), (Jan.–Feb. 1971), SD Catalog No. C13.22/sec.A:75/1.

Abramowitz, S., and Acquista, N., The infrared spectrum of matrix isolated BaO_2.

Boyd, M. E., Quantum corrections to the second virial coefficient for the Lennard–Jones (m-6) potential.

Cezairliyan, A., McClure, J. L., and Beckett, C. W., High-speed (subsecond) measurement of heat capacity, electrical resistivity, and thermal radiation properties of tantalum in the range 1900 to 3200 K.

Dickens, B., and Bowen, J. S., Refinement of the crystal structure of the aragonite phase of $CaCO_3$.

Fearn, J. E., Synthesis of fluorodienes.

Goodwin, R. D., Thermophysical properties of methane: Orthobaric densities and some thermal properties.

Zapas, L. J., and Phillips, J. C., Simple shearing flows in polyisobutylene solutions.

OTHER NBS PUBLICATIONS

Brinckman, F. E., Wachtman, J. B., Jr., Editors, Research materials developed under the NBS inorganic materials program, Nat. Bur. Stand. (U.S.), Spec. Publ. 333, 71 pages (Sept. 1970) 70 cents, SD Catalog No. C13.10:333.

Bullis, W. M., Baroody, A. J., Jr., Methods of measurement for semiconductor materials, process control, and devices, Quarterly Report—January 1 to March 31, 1970, Nat. Bur. Stand. (U.S.), Tech. Note 555, 63 pages (Sept. 1970) 65 cents, SD Catalog No. C13.46:555.

Cezairliyan, A., Morse, M. S., Berman, H. A., Improvements in oscilloscopic measurements in high-speed experiments, Nat. Bur. Stand. (U.S.), Tech. Note 539, 20 pages (Oct. 1970) 30 cents, SD Catalog No. C13.46:539.

Groth, H. G., Wellmann, P., Editors, Spectrum formation in stars with steady-state extended atmospheres, Proceedings of the International Astronomical Union Colloquium No. 2, Commission 36, Munich, Germany, April 16–19, 1969, Nat. Bur. Stand. (U.S.), Spec. Publ. 332, 342 pages (Aug. 1970) $1.75, SD Catalog No. C13.10:332.

Hayward, E., Photonuclear reactions, Nat. Bur. Stand. (U.S.), Monogr. 118, 46 pages (Aug. 1970) 50 cents, SD Catalog No. C13.44:118.

Joiner, B. L., Laubscher, N. F., Brown, E. S., Levy, B., An author and permuted title index to selected statistical journals, Nat. Bur. Stand. (U.S.), Spec. Publ. 321, 510 pages (Sept. 1970) $5.75, SD Catalog No. C13.10:321.

Lide, D. R., Jr., Editor, Critical evaluation of data in the physical sciences—A status report on the National Standard Reference Data System—June 1970, Nat.

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Bur. Stand. (U.S.), Tech. Note 553, 77 pages (Sept. 1970) 70 cents, SD Catalog No. C13.46:553.

Menis, O., Shultz, J. I., Editors, Analytical coordination chemistry section: Summary of activities July 1969–June 1970, Nat. Bur. Stand. (U.S.), Tech. Note 544, 151 pages (Sept. 1970) $1.25, SD Catalog No. C13.46:544.

Moore, C. E., Ionization potentials and ionization limits derived from the analyses of optical spectra, Nat. Stand. Ref. Data Ser., Nat. Bur. Stand. (U.S.), 34, 22 pages (Sept. 1970) 75 cents, SD Catalog No. C13.48:34.

Stevenson, D. R., Technical Standards Coordinator, Rigid poly(vinyl chloride) (PVC) profile extrusions, Nat. Bur. Stand. (U.S.), Prod. Stand. 26–70, 7 pages (Oct. 1970) 10 cents, SD Catalog No. C13.20/2:26–70.

Swanson, H. E., McMurdie, H. F., Morris, M. C., Evans, E. H., Standard x-ray diffraction powder patterns, Nat. Bur. Stand. (U.S.), Monogr. 25—Section 8, 171 pages (Sept. 1970) $1.50, SD Catalog No. C13.44:25/sec.8.

Weisman, H. M., Sherwood, G. B., Annotated accession list of data compilations of the office of standard reference data, Nat. Bur. Stand. (U.S.), Tech. Note 554, 196 pages (Sept. 1970) $1.50, SD Catalog No. C13.46:554.

PUBLICATIONS IN OTHER JOURNALS

This column lists all publications by the NBS staff, as soon after issuance as practical. For completeness, earlier references not previously reported may be included from time to time.

Acquista, N., Abramowitz, S., Structure of the alkali hydroxides. V. The infrared spectra of matrix-isolated RbOH, RbOD, NaOH, and NaOD, J. Chem. Phys. **51**, No. 7, 2911–2914 (Oct. 1969).

Acquista, N., Schoen, L. J., Matrix isolation spectrum of the SH radical, J. Chem. Phys. **53**, No. 3, 1290–1291 (Aug. 1970).

Ahearn, A. J., Homogeneity of ion sensitive emulsions and precision of ion beam measurements in spark source mass spectrometry, (Summary), Proc. 16th Ann. Conf. on Mass Spectrometry and Allied Topics, May 12–17, 1968, Pittsburgh, Pa., sponsored by ASTM Committee E14, pp. 273–276 (1968).

Anderson, H. J., Brenner, A., Chemical vapor deposition of rhenium, Proc. 2d Intern. Conf. on Chemical Vapor Deposition, Los Angeles, Calif., May 1970, pp. 356–366 (1970).

Andrews, J. R., Improved bias supply for tunnel-diode picosecond pulse generators, IEEE Trans. Instr. Meas. **IM–19**, No. 3, 171–175 (Aug. 1970).

Armstrong, R. W., Waters, H. P., Testing programs and research on restraint systems, Proc. Intern. Engineering Congress, Detroit, Mich., January 13–17, 1969, Report No. 690247, pp. 1–48 (Society of Automotive Engineers, New York, N.Y., 1969); Abstract in SAE Trans. **78**, 102 (1969).

Armstrong, R. W., Waters, H. P., Stap, J. P., Human muscular restraint during sled deceleration, Proc. 1968 Stapp Car Crash Conf., October 22–23, 1968, Detroit, Mich., Report No. 680793, pp. 440–462 (Society of Automotive Engineers, New York, N.Y., 1969); Abstract in SAE Trans. **77**, 179 (1969).

Arthur, M. G., Impulse spectral intensity calibration at the National Bureau of Standards, Proc Electromagnetic Compatability Symp., Mt. Monmouth, N.J., June 19–20, 1969, pp. 133–138 (U.S. Army Electronics Command Hdq., Ft. Monmouth, N.J., 1969).

Ausloos, P., Ion-molecule reactions and photoionization of hydrocarbons, Chapter in Progress in Reaction Kinetics, G. Porter, Ed., **5**, 113–179 (Mar.–Apr. 1970).

Ausloos, P., Lias, S. G., Carbonium ions in radiation chemistry. Reactions of t-butyl ions with hydrocarbons, J. Am. Chem. Soc. **92**, No. 17, 5037–5045 (Aug. 1970).

Baird, R. C., Recent theoretical and experimental results of the determination of antenna pattern and gain from near-field measurements (Summary), Proc. Conf. on Precision Electromagnetic Measurements, National Bureau of Standards, Boulder, Colo., June 2–5, 1970, CPEM Digest, p. 60 (1970).

Baird, R. C., Newell, A. C., Wacker, P. F., Kerns, D. M., Recent experimental results in near-field antenna measurements, Electron. Letters **6**, No. 11, 349–351 (May 1969).

Barnes, J. A., Frequency measurement errors of passive resonators caused by frequency-modulataed exciting signals, IEEE Trans. Instr. Meas. **IM–19**, No. 3, 147–152 (Aug. 1970).

Bates, R. D., Jr., Flynn, G. W., Ronn, A. M., Laser-induced vibrational fluorescence in nitrous oxide, J. Chem. Phys. **49**, No. 3, 1432–1433 (1968).

Bates, R. G., Staples, B. R., Robinson, R. A., Ionic hydration and single ion activities in unassociated chlorides at high ionic strengths, Anal. Chem. **42**, No. 8, 867–871 (July 1970).

Bergstrom, J. C., Bertozzi, W., Kowalski, S., Maruyama, X. K., Lightbody, Jr., J. W., Fivozinsky, S. P., Penner, S., Electroexcitation of the low-lying states of O^{16}, Phys. Rev. Letters **24**, No. 4, 152–155 (Jan. 1970).

Blaine, R. L., A statistical study of the effects of trace elements on the properties of portland cement, Proc. 5th Intern. Symp. on the Chemistry of Cements, Tokyo, Japan, October 7–11, 1968, **3**, Part 3, 86–91 (Dec. 1969).

Blaugher, R. D., Hein, R. E., Cox, J. E., Waterstrat, R. M., Atomic ordering and superconductivity in A–15 compounds, J. Low Temp. Phys. **1**, No. 6, 539–561 (Dec. 1969).

Bennett, H. S., Two-electron F′ centers in the alkaline-earth oxides and in the alkali halides, Phys. Rev. B **1**, No. 4, 1702–1715 (Feb. 1970).

Berger, M. J., Beta-ray dosimetry calculations with the use of point kernels (Proc. Symp. on Medical Radionuclides: Radiation Dose and Effects, Oak Ridge Associated Universities, Oak Ridge, Tenn.), Atomic Energy Commission Report CONF–691212, pp. 63–86 (June 1970).

Boyne, H. S., Hall, J. L., Barger, R. L., Bender, P. L., Ward, J., Levine, J., Faller, J., Absolute strain measurements with a 30-meter vacuum interferometer (Proc. Conf. Laser Applications in the Geosciences, Huntington Beach, Calif., June 1969), Chapter in Laser Applications in the Geosciences, J. Gauger and F. F. Hall, Jr., Eds., pp. 215–225 (Western Periodicals, North Hollywood, Calif., 1970).

Brady, R. F., Jr., Cyclic acetals of ketoses, Part III. Re-investigation of the synthesis of the isomeric Di-O-isopropylidene-β—D-fructopyranoses, Carbohydrate Res. **15**, No. 1, 35–40 (1970).

Bridges, J. M., Wiese, W. L., Transition probabilities for the prominent red lines of Ne I, Phys. Rev. A **2**, No. 2, 285–293 (Aug. 1970).

Brown, D. W., Lowry, R. E., Wall, L. A., Radiation-induced copolymerization of tetrafluoroethylene and 3,3,4,4,5,5,5-heptafluoropentene-1 under pressure, J. Polymer Sci. Part A–1, **8**, No. 9, 2441–2452 (1970).

Bullis, W. M., Scace, R. I., Measurement standards for integrated circuit processing, Proc. IEEE **57**, No. 9, 1639–1646 (Sept. 1969).

Casella, R. C., Possible failure of the Pomeranchuk theorum—Shrinkage of the forward elastic peak, Phys. Rev. Letters **24**, No. 25, 1463–1466 (June 1970).

Cezairliyan, A., McClure, J. L., Morse, M. S., Beckett, C. W., Measurement of heat capacity of tantalum in the range 1900–3000 K by a pulse heating method, Proc.

U. S. GOVERNMENT PRINTING OFFICE : 1971 O - 411-036